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SEPTEMBER, 1851.

CIVIL ENGINEERING.

On the Nominal Horse Power of Steam Engines. *By* COMMANDER L. G. HEATH, R. N.*

The inadequacy of the present term "nominal horse power" for giving a definite idea of either the absolute or relative power of engines was first examined, by comparing the engines of H. M. steamships Garland and Basilisk, which were both constructed on the same principle, with oscillating cylinders, and were both used to drive paddle wheels. This comparison was made under three distinct heads,—the mean effective pressure, the number of revolutions per minute, and the size of the cylinders. It was urged that Watt's constant of seven pounds per square inch, for the mean effective pressure, was not only in itself inapplicable, but that no constant quantity could be universally applicable. Also, that the method of determining the number of revolutions per minute, from a conventional speed, founded on the length of stroke of the piston, was equally fallacious. It was therefore proposed, that the term "nominal horse power" should be abolished; and that engines should in future be designated by the cubic contents of their steam cylinders, jointly with their nominal consumption of a standard description of fuel during a given period of one hour. A table might be drawn up giving this nominal consumption in terms of the grate and the heating surface, and should be accompanied by rules and directions for ensuring the uniform measurement of the grate and the heating surface. This system, it was contended, would be more in accordance with the present practice of construction, and would enable the relative size and power of engines to be more accurately estimated than by the present method.—*Proc. Insti. Civ. Eng., April* 8, 1851.

* From the London Athenæum, April 8, 1851.

It was admitted that it would be very desirable to fix the nomenclature of the power of engines; for though it was well known that James Watt did really take as his standard, what he found to be actually performed by a powerful horse drawing a weight over a pulley,—viz: the equivalent of 33,000 lbs. raised one foot high in a minute—yet commercially it had gradually become a custom among the manufacturers to give a surplus of power, ostensibly as an allowance for the friction and deficiencies of the machine, so that now, the mere statement of the nominal horse power had no definite meaning. It was, however, contended that the standard of 33,000 lbs. should be retained; and that, supposing the workmanship to be equally good in two engines, it was only necessary to compare the areas of the cylinders, the effective pressure of steam on the piston, and the speed of the piston, to determine their relative power. This was, in fact, shown by the indicator, an instrument the value of which was now universally admitted, and which, when skilfully used, did really give a true representation of the power of the engine. It was the universal custom of Boulton and Watt to calculate the power exerted by an engine by the speed of the piston, together with the average pressure of the steam, as shown by the indicator; and although much vagueness and uncertainty had latterly been introduced into the subject, this was rather to be attributed to the assumption of arbitrary quantities to represent those results, than to any defect in Watt's standard horse-power, which definitely expressed both the measure of power and the space through which it acted. The proposed standard of comparison of the quantity of water evaporated in a given time, by a given amount of fuel, or the combustion of a given quantity of fuel in a given time, were shown to be of no value; as then not only the generation of the steam, but the administration of it, must be considered, and these were points merely tending to complicate the question. For pumping engines in Cornwall, the term horse-power, was almost unknown, engines being sold to raise a given quantity of water, which was a standard easily reducible to that of other districts, where 33,000 lbs. was assumed to be the actual power of a horse.—*Proc. Inst. Civ. Eng., April* 15, 1851.

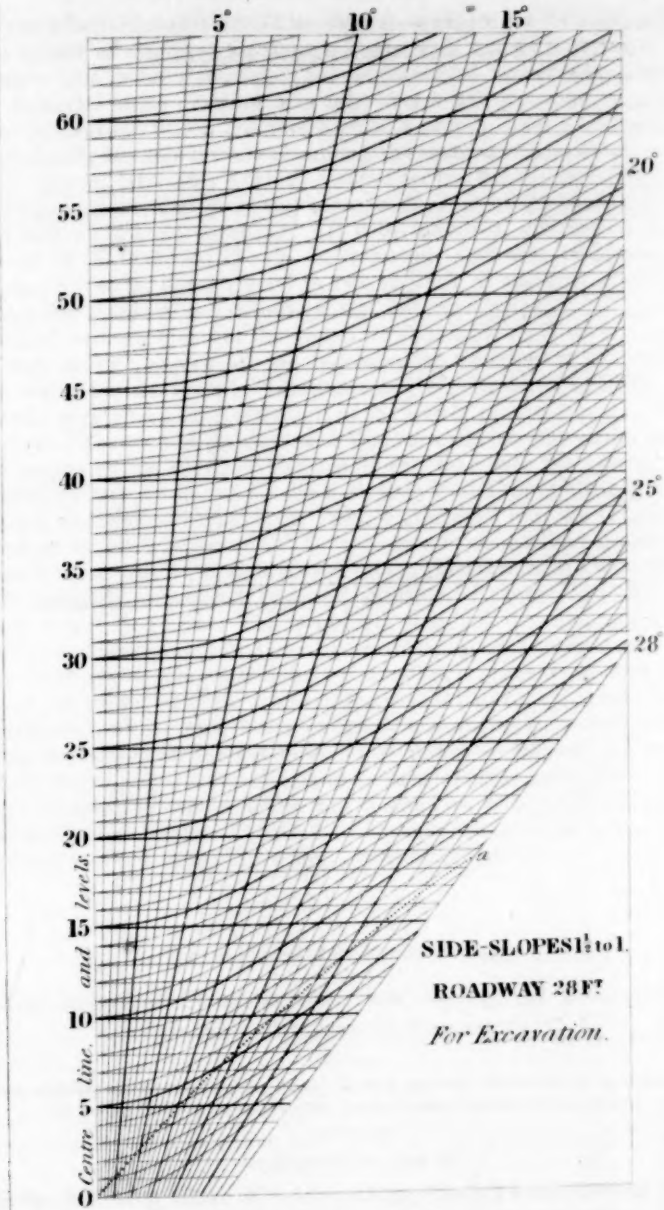
For the Journal of the Franklin Institute.

A New Method of Calculating the Cubic Contents of Excavations and Embankments.—By John C. Trautwine, C. E.

Entered, according to the Act of Congress, in the year 1851, by John C. Trautwine, in the Clerk's Office of the District Court of the United States, for the Eastern District of Pennsylvania.

Continued from page 88.

In the following tables of level cuttings, the left hand vertical column contains the height or depth of the embankment or excavation, in feet; and the upper horizontal column, the intermediate tenths of a foot. Thus in table 1, the cubic yards in a station 100 feet long and 10 feet deep, are 1074; for 10·1 deep, 1090; for 10·2 deep, 1107, &c.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Centre line. and levels.
a
SIDE-SLOPES 1½ to 1.
ROADWAY 28 Ft.
For Excavation.

TABLE 9.—LEVEL CUTTINGS.

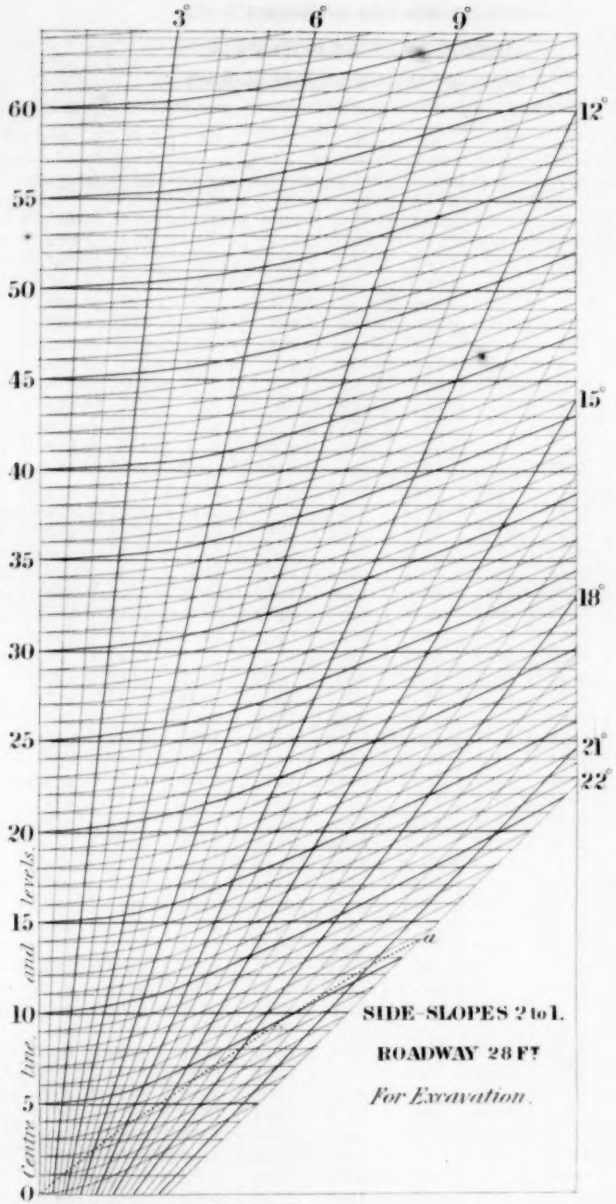
Roadway 28 *feet wide, side-slopes* 1½ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	21·0	31·6	42·4	53·2	64·2	75·3	86·5	97·9
1	109·3	120·8	132·5	144·3	156·1	168·1	180·2	192·4	204·8	217·2
2	229·6	242·3	255·0	267·9	280·9	294·0	307·2	320·5	334·0	347·5
3	361·2	374·9	388·8	402·8	416·9	431·1	445·4	459·9	474·4	489·1
4	503·7	518·6	533·6	548·6	563·9	579·3	594·7	610·2	625.8	641·6
5	657·5	673·4	689·5	705·7	722·1	738·5	755·0	771·7	788·4	805·3
6	822·2	839·3	856·5	873·8	891·2	908·8	926·4	944·2	962·0	980·0
7	998·1	1016	1035	1053	1072	1090	1109	1128	1147	1166
8	1185	1204	1224	1243	1263	1283	1303	1322	1343	1363
9	1383	1403	1424	1445	1465	1486	1507	1528	1549	1571
10	1592	1614	1635	1657	1679	1701	1723	1745	1767	1790
11	1812	1835	1858	1881	1904	1927	1950	1973	1997	2020
12	2044	2068	2092	2116	2140	2164	2189	2213	2238	2262
13	2287	2312	2337	2362	2387	2413	2438	2464	2489	2515
14	2541	2567	2593	2619	2645	2672	2698	2725	2752	2779
15	2806	2833	2860	2887	2915	2942	2970	2997	3026	3053
16	3081	3109	3138	3166	3195	3223	3252	3281	3310	3339
17	3368	3397	3427	3456	3486	3516	3546	3576	3606	3636
18	3667	3697	3728	3758	3789	3820	3851	3882	3913	3944
19	3976	4007	4039	4070	4102	4134	4166	4198	4231	4263
20	4296	4328	4361	4394	4427	4460	4493	4527	4560	4594
21	4627	4661	4695	4729	4763	4797	4832	4866	4900	4935
22	4970	5005	5040	5075	5111	5146	5181	5217	5253	5288
23	5324	5360	5396	5432	5469	5505	5542	5578	5615	5652
24	5689	5726	5763	5800	5838	5875	5913	5951	5989	6027
25	6065	6103	6141	6179	6218	6257	6295	6334	6373	6412
26	6451	6491	6530	6570	6609	6649	6689	6729	6769	6809
27	6850	6890	6931	6971	7012	7053	7094	7135	7176	7217
28	7259	7300	7342	7384	7426	7468	7510	7552	7594	7637
29	7680	7722	7765	7808	7851	7894	7937	7981	8024	8067
30	8111	8155	8199	8243	8287	8331	8375	8420	8464	8509
31	8554	8598	8643	8688	8734	8779	8824	8870	8915	8961
32	9007	9053	9099	9145	9191	9238	9284	9331	9378	9425
33	9472	9519	9566	9613	9661	9708	9756	9804	9851	9900
34	9948	9997	10045	10093	10142	10190	10239	10288	10337	10386
35	10435	10484	10534	10583	10633	10683	10733	10782	10832	10882
36	10933	10983	11034	11084	11135	11186	11237	11288	11339	11391
37	11443	11494	11546	11598	11649	11701	11753	11806	11858	11910
38	11963	12016	12068	12121	12174	12227	12281	12334	12387	12441
39	12494	12584	12602	12656	12710	12764	12819	12873	12928	12982
40	13037	13092	13147	13202	13257	13312	13368	13423	13479	13535
41	13591	13647	13703	13759	13815	13872	13928	13985	14042	14099
42	14156	14213	14270	14327	14385	14442	14500	14558	14615	14673
43	14731	14790	14848	14906	14965	15024	15082	15141	15200	15259
44	15318	15378	15437	15497	15556	15616	15676	15736	15796	15856
45	15917	15977	16038	16098	16159	16220	16281	16342	16403	16465
46	16526	16587	16649	16711	16773	16835	16897	16959	17021	17084
47	17146	17209	17272	17335	17398	17461	17524	17587	17651	17714
48	17778	17842	17905	17969	18033	18098	18162	18226	18291	18356
49	18420	18485	18550	18615	18680	18746	18811	18877	18942	19008
50	19074	19140	19206	19272	19339	19405	19472	19538	19605	19672
51	19739	19806	19873	19940	20008	20075	20143	20211	20279	20347
52	20415	20483	20551	20620	20688	20757	20826	20894	20963	21032
53	21102	21171	21241	21310	21380	21450	21519	21589	21659	21730
54	21800	21870	21941	22012	22082	22153	22224	22295	22366	22438
55	22509	22581	22652	22724	22796	22868	22940	23012	23085	23157
56	23230	23302	23375	23448	23521	23594	23667	23741	23814	23888
57	23961	24035	24109	24183	24257	24331	24405	24480	24554	23629
58	24704	24779	24854	24929	25004	25079	25155	25230	25306	25381
59	25457	25533	25609	25686	25762	25838	25915	25992	26068	26145
60	26222	26299	26376	26454	26531	26609	26686	26764	26842	26920

TABLE 10.—LEVEL CUTTINGS.

Roadway 28 *feet wide, side-slopes* 2 *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	5.	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	21·0	31·8	42·7	53·7	64·9	76·2	87·7	99·3
1	111·1	123·0	135·1	147·3	159·7	172·2	184·9	197·7	210·7	223·8
2	237·0	250·4	264·0	277·7	291·6	305·6	319·7	334·0	348·4	363·0
3	377·8	392·7	407·7	422·9	438·2	453·7	469·3	485·1	501·0	517·1
4	533·3	549·7	566·2	582·9	599·7	616·6	633·7	651·0	668·4	686·0
5	703·7	721·5	739·5	757·7	776·0	794·4	813·0	831·7	850·6	869·6
6	888·9	908·2	927·7	948·3	968·1	988·1	1008	1028	1049	1069
7	1090	1111	1132	1153	1174	1195	1217	1239	1260	1282
8	1305	1327	1349	1372	1394	1417	1440	1464	1487	1510
9	1533	1557	1581	1605	1629	1654	1678	1703	1728	1753
10	1778	1803	1828	1854	1880	1905	1931	1958	1984	2010
11	2037	2064	2091	2118	2145	2172	2200	2227	2255	2283
12	2311	2339	2368	2396	2425	2454	2483	2512	2541	2570
13	2600	2630	2659	2689	2720	2750	2780	2811	2842	2873
14	2904	2935	2966	2998	3029	3061	3093	3125	3157	3190
15	3222	3255	3288	3321	3354	3387	3420	3454	3488	3521
16	3555	3590	3624	3658	3693	3728	3763	3798	3833	3868
17	3904	3939	3975	4011	4047	4083	4120	4156	4193	4230
18	4267	4304	4341	4378	4416	4454	4492	4529	4568	4606
19	4644	4683	4722	4761	4800	4839	4878	4918	4957	4997
20	5037	5077	5117	5158	5198	5239	5280	5321	5362	5403
21	5444	5486	5528	5570	5612	5654	5696	5738	5781	5824
22	5867	5910	5953	5996	6040	6083	6127	6171	6215	6259
23	6303	6348	6393	6438	6483	6528	6573	6618	6664	6710
24	6756	6802	6848	6894	6941	6987	7034	7081	7128	7175
25	7222	7270	7317	7365	7413	7461	7509	7558	7606	7655
26	7704	7753	7802	7851	7900	7950	8000	8049	8099	8150
27	8200	8250	8301	8352	8403	8454	8505	8556	8608	8659
28	8711	8763	8815	8867	8920	8972	9025	9078	9131	9184
29	9237	9290	9344	9398	9451	9506	9560	9614	9668	9723
30	9778	9833	9888	9943	9998	10054	10109	10165	10221	10277
31	10333	10390	10446	10503	10560	10617	10674	10731	10788	10846
32	10904	10961	11019	11078	11136	11194	11253	11312	11371	11430
33	11489	11548	11608	11667	11727	11787	11847	11907	11968	12028
34	12089	12150	12211	12272	12333	12394	12456	12518	12580	12642
35	12704	12766	12828	12891	12954	13017	13080	13143	13206	13270
36	13333	13397	13461	13525	13589	13654	13718	13783	13848	13913
37	13978	14043	14108	14174	14240	14305	14371	14438	14504	14570
38	14637	14704	14770	14838	14905	14972	15040	15107	15175	15243
39	15311	15379	15448	15516	15585	15654	15723	15792	15861	15930
40	16000	16070	16140	16210	16280	16350	16420	16491	16562	16633
41	16704	16775	16846	16918	16989	17061	17133	17205	17277	17350
42	17422	17495	17568	17641	17714	17787	17860	17934	18008	18081
43	18156	18230	18304	18378	18453	18528	18603	18678	18753	18828
44	18904	18979	19055	19131	19207	19283	19360	19436	19513	19590
45	19667	19744	19821	19898	19976	20054	20132	20210	20288	20366
46	20444	20523	20602	20681	20760	20839	20918	20998	21077	21157
47	21237	21317	21397	21478	21558	21639	21720	21801	21882	21963
48	22044	22126	22208	22290	22372	22454	22536	22618	22701	22784
49	22867	22950	23033	23116	23200	23283	23367	23451	23535	23619
50	23704	23788	23873	23958	24043	24128	24213	24298	24384	24470
51	24556	24642	24728	24814	24900	24987	25074	25161	25248	25335
52	25422	25510	25597	25865	25773	25861	25949	25038	26126	26215
53	26304	26393	26482	26571	26660	26750	26840	26930	27020	27110
54	27200	27290	27381	27472	27563	27654	27745	27836	27928	28019
55	28111	28203	28295	28387	28480	28572	28665	28758	28851	28944
56	29037	29130	29224	29318	29412	29506	29600	29694	29788	29883
57	29978	30073	30168	30263	30358	30454	30549	30645	30741	30837
58	30933	31030	31126	31223	31320	31417	31514	31611	31708	31806
59	31904	32002	32100	32198	32296	32394	32493	32592	32691	32790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Centre line and levels.
a
SIDE-SLOPES 2 to 1.
ROADWAY 28 Ft.
For Excavation.

TABLE 11.—LEVEL CUTTINGS.

Roadway 18 *feet wide, side-slopes,* ½ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	7.	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		6·68	13·4	20·1	26·8	33·6	40·3	47·1	53·9	60·8
1	67·6	74·5	81·3	88·2	95·1	102·1	109·0	116·0	123·0	130·0
2	137·0	144·1	151·1	158·2	165·3	172·4	179·5	186·7	193·9	201·0
3	208·2	215·5	222·7	230·0	237·2	244·5	251·9	259·2	266·5	274·0
4	281·5	288·9	296·3	303·8	311·3	318·8	326·3	333·8	341·3	348·9
5	356·5	364·1	371·7	379·3	387·0	394·7	402·4	410·1	417·8	425·6
6	433·3	441·1	448·9	456·7	464·6	472·5	480·3	488·2	496·1	504·1
7	512·0	520·0	528·0	536·0	544·1	552·1	560·2	568·3	576·4	584·0
8	592·6	600·8	608·9	617·1	625·3	633·6	641·8	650·1	658·4	666·7
9	675·0	683·3	691·7	700·1	708·5	716·9	725·3	733·8	742·3	750·7
10	759·3	767·8	776·3	784·9	793·5	802·1	810·7	819·3	828·0	836·7
11	845·4	854·1	862·8	871·6	880·3	889·1	897·9	906·7	915·6	924·4
12	933·3	942·2	951·1	960·1	969·0	978·0	987·0	996·0	1005	1014
13	1023	1032	1041	1050	1060	1069	1078	1087	1096	1106
14	1115	1124	1133	1143	1152	1161	1171	1180	1189	1199
15	1208	1218	1227	1237	1246	1256	1265	1275	1284	1294
16	1304	1313	1323	1333	1342	1352	1362	1372	1381	1391
17	1401	1411	1421	1430	1440	1450	1460	1470	1480	1490
18	1500	1510	1520	1530	1540	1550	1560	1570	1580	1591
19	1601	1611	1621	1631	1642	1652	1962	1672	1683	1693
20	1703	1714	1724	1735	1745	1755	1766	1777	1787	1798
21	1808	1818	1829	1840	1850	1861	1872	1883	1894	1905
22	1916	1926	1937	1947	1958	1969	1980	1991	2002	2013
23	2024	2035	2046	2057	2068	2079	2090	2101	2111	2122
24	2133	2144	2156	2167	2178	2189	2200	2212	2223	2234
25	2245	2256	2268	2279	2290	2301	2313	2324	2336	2347
26	2359	2371	2382	2394	2106	2117	2129	2140	2152	2461
27	2475	2486	2498	2510	2521	2533	2545	2557	2569	2581
28	2592	2604	2616	2628	2640	2652	2664	2676	2688	2700
29	2712	2724	2736	2748	2760	2772	2784	2797	2809	2821
30	2833	2845	2858	2870	2882	2894	2907	2919	2931	2944
31	2956	2969	2981	2994	3006	3018	3031	3044	3056	3069
32	3081	3094	3107	3119	3132	3145	3157	3170	3183	3195
33	3208	3221	3234	3247	3260	3272	3285	3298	3311	3324
34	3337	3350	3363	3376	3389	3402	3415	3428	3441	3454
35	3467	3481	3494	3507	3520	3533	3547	3560	3573	3587
36	3600	3613	3627	3640	3653	3667	3680	3694	3707	3721
37	3734	3748	3761	3775	3788	3802	3816	3829	3843	3857
38	3870	3884	3898	3911	3925	3939	3953	3967	3980	3994
39	4008	4022	4036	4050	4064	4078	4092	4106	4120	4134
40	4148	4162	4176	4190	4208	4219	4233	4247	4261	4275
41	4290	4304	4318	4333	4347	4361	4376	4390	4404	4419
42	4433	4448	4462	4477	4491	4506	4520	4535	4549	4564
43	4579	4593	4608	4623	4637	4652	4667	4681	4696	4711
44	4726	4741	4756	4770	4785	4800	4815	4830	4845	4860
45	4875	4890	4905	4920	4935	4950	4965	4980	4995	5011
46	5026	5041	5056	5071	5087	5102	5117	5133	5148	5163
47	5179	5194	5209	5225	5240	5256	5271	5287	5302	5318
48	5333	5349	5364	5380	5396	5411	5427	5443	5458	5474
49	5490	5505	5521	5537	5553	5569	5585	5600	5616	5632
50	5648	5664	5680	5696	5712	5728	5744	5760	5776	5792
51	5808	5824	5840	5858	5873	5889	5905	5921	5938	5954
52	5970	5987	6003	6019	6036	6052	6068	6085	6101	6118
53	6134	6151	6167	6184	6200	6217	6233	6250	6267	6283
54	6300	6317	6333	6350	6367	6383	6100	6117	6134	6451
55	6468	6484	6501	6518	6535	6552	6569	6586	6603	6620
56	6637	6654	6671	6688	6705	6722	6739	6757	6774	6791
57	6808	6825	6843	6860	6877	6895	6912	6929	6947	6964
58	6981	6999	7016	7034	7051	7069	7086	7104	7121	7139
59	7156	7174	7192	7209	7227	7245	7262	7280	7298	7315

TABLE 12.—LEVEL CUTTINGS.

Roadway 28 *feet wide, side-slopes* ½ *to* 1.

Depth in ft.	·0	·1	·2	·3	·4	·5	·6	·7	·8	·9
	cu. yds.	cu. yds.	cu. yds.	cu. yd s	cu. yds.	cu. yds	cu. yds.	cu. yds.	cu. yds.	cu. yds.
0		10·4	20·8	31·2	41·6	52·1	62·6	73·0	83·6	94·1
1	104·6	115·2	125·8	136·4	147·0	157·6	168·3	179·0	189·7	200·4
2	211·1	221·9	232·6	243·4	254·3	265·1	275·9	286·8	297·7	308·6
3	319·4	330·4	341·3	352·3	363·3	374·3	385·4	396·4	407·5	418·6
4	429·7	440·8	451·9	463·1	474·3	485·5	496·7	508·0	519·2	530·5
5	541·7	553·0	564·3	575·6	587·0	598·4	609·7	621·1	632·6	644·0
6	655·6	667·1	678·7	690·3	702 0	713·6	725 3	737·0	747·7	759·4
7	771·3	783·0	794·7	806·4	818·1	829·9	841·6	853·4	865·3	877·1
8	888·9	900·8	912·6	923·6	935·5	947·4	959·4	971·4	983·4	995·4
9	1007	1019	1032	1044	1056	1068	1080	1092	1105	1117
10	1130	1142	1154	1166	1179	1191	1203	1216	1228	1240
11	1253	1265	1278	1290	1303	1315	1328	1340	1353	1365
12	1378	1390	1403	1416	1428	1441	1454	1466	1479	1492
13	1505	1517	1530	1543	1556	1569	1582	1595	1607	1620
14	1633	1646	1659	1672	1685	1699	1712	1725	1738	1751
15	1764	1777	1790	1803	1817	1830	1843	1856	1870	1883
16	1896	1910	1923	1936	1950	1963	1977	1990	2004	2017
17	2031	2044	2058	2071	2085	2098	2112	2126	2139	2153
18	2167	2180	2194	2208	2222	2235	2249	2263	2277	2291
19	2305	2318	2332	2346	2360	2374	2388	2402	2416	2430
20	2444	2459	2473	2487	2501	2515	2529	2543	2558	2572
21	2586	2600	2615	2629	2643	2658	2672	2686	2701	2715
22	2730	2744	2759	2773	2788	2802	2817	2831	2846	2860
23	2875	2890	2904	2919	2934	2948	2963	2978	2993	3007
24	3022	3037	3052	3067	3082	3097	3111	3126	3141	3156
25	3171	3186	3201	3216	3232	3247	3262	3277	3292	3307
26	3322	3337	3353	3368	3383	3398	3414	3429	3444	3460
27	3475	3490	3506	3521	3537	3552	3568	3583	3599	3614
28	3630	3645	3661	3676	3692	3708	3723	3739	3755	3770
29	3786	3802	3818	3833	3849	3865	3881	3897	3913	3928
30	3944	3960	3976	3992	4008	4024	4040	4056	4072	4088
31	4105	4121	4137	4153	4169	4185	4202	4218	4234	4250
32	4267	4283	4299	4316	4332	4348	4365	4381	4398	4414
33	4431	4447	4464	4480	4497	4513	4530	4546	4563	4580
34	4596	4613	4630	4646	4663	4680	4697	4713	4730	4747
35	4764	4781	4797	4814	4831	4848	4865	4882	4899	4916
36	4933	4950	4967	4984	5001	5018	5036	5053	5070	5087
37	5104	5121	5138	5155	5173	5190	5207	5225	5242	5259
38	5278	5295	5313	5330	5348	5365	5383	5400	5418	5436
39	5453	5471	5488	5505	5523	5541	5559	5576	5594	5612
40	5630	5647	5665	5683	5701	5719	5737	5755	5772	5790
41	5808	5826	5844	5862	5880	5898	5916	5935	5953	5971
42	5989	6007	6025	6043	6062	6080	6098	6116	6135	6153
43	6171	6190	6208	6226	6245	6263	6282	6300	6319	6337
44	6356	6374	6393	6411	6430	6448	6467	6486	6504	6523
45	6542	6560	6579	6598	6617	6635	6654	6673	6692	6711
46	6730	6749	6767	6786	6805	6824	6843	6862	6881	6900
47	6919	6938	6958	6977	6996	7015	7034	7053	7072	7092
48	7111	7130	7150	7169	7188	7208	7227	7246	7266	7285
49	7305	7324	7343	7363	7382	7402	7422	7441	7461	7480
50	7500	7520	7539	7559	7579	7598	7618	7638	7658	7677
51	7697	7717	7737	7757	7777	7796	7816	7836	7856	7876
52	7896	7916	7936	7956	7976	7997	8017	8037	8057	8077
53	8097	8117	8138	8158	8178	8198	8219	8239	8259	8280
54	8300	8320	8341	8361	8382	8102	8423	8443	8464	8484
55	8505	8525	8546	8566	8587	8608	8628	8649	8670	8690
56	8711	8732	8753	8773	8794	8815	8836	8857	8878	8899
57	8919	8940	8961	8932	9003	9024	9045	9066	9087	9109
58	9130	9151	9172	9193	9214	9235	9257	9278	9299	9320
59	9342	9363	9384	9406	9427	9448	9470	9491	9513	9534

TABLE 13.—LEVEL CUTTINGS.

Continuation of the foregoing Tables of Cubic Contents to 100 *feet of height or depth.*

Height or Depth in feet.	TABLE 1	TABLE 2	TABLE 3	TABLE 4	TABLE 5	TABLE 6	TABLE 7	TABLE 8	TABLE 9	TABLE 10	TABLE 11	TABLE 12
	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu yd.	cu. yds.	cu. yds.
61	23835	26094	17848	21294	24739	31630	20107	23553	26998	33889	7512	9771
·5	24201	26479	18108	21610	25113	32117	20386	23888	27390	34394	7602	9880
62	24570	26867	18370	21930	25489	32607	20667	24226	27785	34904	7693	9989
·5	24942	27257	18634	22251	25868	33102	20949	24566	28183	35417	7784	10098
63	25317	27650	18900	22575	26250	33600	21233	24908	28583	35933	7875	10208
·5	25694	28046	19168	22901	26635	34102	21519	25253	28986	36454	7967	10319
64	26074	28444	19437	23230	27022	34607	21807	25600	29393	36978	8059	10430
·5	26457	28846	19708	23560	27413	35117	22097	25949	29801	37506	8152	10541
65	26843	29250	19981	23894	27806	35630	22389	26300	30213	38037	8245	10653
·5	27231	29657	20256	24229	28201	36146	22682	26654	30627	38572	8339	10765
66	27622	30067	20533	24567	28600	36667	22978	27011	31044	39111	8433	10878
·5	28016	30479	20812	24907	29001	37191	23275	27369	31464	39654	8528	10991
67	28413	30891	21093	25249	29406	37719	23574	27730	31887	40200	8623	11105
·5	28812	31313	21375	25594	29813	38250	23875	28093	32312	40750	8719	11219
68	29215	31733	21659	25941	30222	38785	24178	28459	32741	41304	8815	11333
·5	29620	32157	21945	26290	30635	39324	24482	28827	33172	41861	8911	11448
69	30028	32583	22233	26642	31050	39867	24789	29197	33605	42422	9008	11564
·5	30438	33013	22523	26995	31468	40413	25097	29569	34042	42987	9106	11680
70	30852	33444	22814	27352	31889	40963	25407	29944	34481	43556	9204	11796
·5	31268	33879	23108	27710	32313	41517	25719	30321	34924	44128	9302	11913
71	31687	34317	23404	28071	32739	42074	26033	30701	35369	44704	9401	12031
·5	32108	34757	23701	28434	33168	42635	26349	31083	35816	45283	9500	12148
72	32533	35200	24000	28800	33600	43200	26667	31467	36267	45867	9600	12267
·5	32960	35646	24310	29168	34035	43769	26986	31853	36720	46451	9700	12385
73	33390	36094	24604	29538	34472	44341	27307	32241	37176	47044	9801	12505
·5	33823	36546	24907	29910	34913	44917	27631	32632	37635	47639	9902	12624
74	34259	37000	25214	30285	35356	45496	27956	33026	38096	48237	10004	12744
·5	34697	37457	25522	30662	35801	46080	28282	33421	38561	48839	10106	12865
75	35139	37917	25832	31042	36250	46667	28611	33819	39028	49444	10208	12986
·5	35582	38379	26144	31423	36701	47257	28942	34219	39498	50054	10311	13108
76	36029	38844	26458	31807	37156	47852	29174	34622	39970	50667	10415	13230
·5	36479	39313	26774	32194	37613	48450	29608	35027	40446	51283	10519	13352
77	36931	39783	27092	32582	38072	49052	29944	35431	40924	51904	10623	13475
·5	37386	40257	27411	32973	38535	49657	30282	35843	41405	52528	10728	13598
78	37844	40733	27733	33367	39000	50267	30622	36256	41889	53156	10833	13722
·5	38305	41213	28056	33762	39468	50880	30964	36669	42375	53787	10939	13846
79	38768	41694	28381	34160	39939	51496	31307	37086	42865	54422	11045	13971
·5	39235	42179	28708	34560	40413	52117	31653	37504	43357	55061	11152	14096
80	39701	42667	29037	34963	40889	52741	32000	37926	43852	55704	11259	14222
81	40650	43650	29700	35775	41850	54000	32700	38775	44850	57000	11475	14475
82	41607	44644	30370	36596	42822	55274	33407	39633	45859	58311	11693	14730
83	42576	45650	31048	37427	43806	56563	34122	40501	46880	59637	11912	14986
84	43555	46667	31733	38267	44800	57867	34844	41378	47911	60978	12133	15244
85	44546	47694	32426	39116	45806	59185	35574	42264	48954	62333	12357	15505
86	45548	48733	33126	39974	46822	60519	36311	43159	50008	63704	12582	15767
87	46561	49783	33833	40842	47850	61867	37056	44061	51072	65089	12808	16031
88	47585	50844	34548	41718	48889	63230	37807	44978	52148	66489	13037	16296
89	48620	51917	35270	42605	49939	64607	38567	45901	53235	67904	13268	16564
90	49667	53000	36000	43500	51000	66000	39333	46833	54333	69333	13500	16833
91	50721	54094	36737	44405	52072	67407	40107	47775	55443	70778	13734	17105
92	51793	55200	37481	45319	53156	68830	40889	48726	56563	72237	13970	17378
93	52872	56317	38233	46242	54250	70267	41678	49686	57694	73711	14208	17653
94	53963	57444	38993	47174	55356	71719	42474	50655	58837	75200	14448	17930
95	55065	58583	39759	48116	56472	73185	43278	51634	59990	76704	14690	18208
96	56178	59733	40533	49067	57600	74667	44089	52622	61155	78222	14933	18489
97	57302	60894	41315	50027	58739	76163	44907	53619	62331	79756	15179	18771
98	58437	62067	42104	50996	59889	77674	45733	54626	63518	81304	15426	19056
99	59583	63250	42900	51975	61050	79200	46567	55642	64716	82867	15675	19342
100	60741	64444	43704	52963	62222	80741	47407	56667	65926	84444	15926	19630

Table 14.

Of cubic yards in a 100 foot station, to be added to, or subtracted from, the quantities in the preceding thirteen tables, in case the excavations or embankments should be increased or diminished 2 feet in width.

The most rapid method of performing this operation would be to add together the average heights, or depths, of the equivalent level cuttings or fillings of several consecutive 100 foot stations, and divide their sum by their number, for an average one of them all. The number of cubic yards corresponding to this average height, or depth, when multiplied by the number of stations, will give the content of the entire length.

It would, however, be better for the assistant, in cases where the width of roadway differs from those in the preceding Tables, to construct at once a new table.

Cubic Yards in a length of 100 *feet; breadth* 2 *feet; and of different depths.*

Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.	Height or Depth in feet.	Cubic Yards.
·5	3·70	·5	152	·5	300	·5	448	·5	596
1	7·41	21	156	41	304	61	452	81	600
·5	11·1	·5	159	·5	307	·5	456	·5	604
2	14·8	22	163	42	311	62	459	82	607
·5	18·5	·5	167	·5	315	·5	463	·5	611
3	22·2	23	170	43	319	63	467	83	615
·5	25·9	·5	174	·5	322	·5	470	·5	619
4	29·6	24	178	44	326	64	474	84	622
·5	33·3	·5	181	·5	330	·5	478	·5	626
5	37·0	25	185	45	333	65	481	85	630
·5	40·7	·5	189	·5	337	·5	485	·5	633
6	44·4	26	193	46	341	66	489	86	637
·5	48·1	·5	196	·5	344	·5	493	·5	641
7	51·9	27	200	47	348	67	496	87	644
·5	55·6	·5	204	·5	352	·5	500	·5	648
8	59·3	28	207	48	356	68	504	88	652
·5	63·0	·5	211	·5	359	·5	507	·5	656
9	66·7	29	215	49	363	69	511	89	659
·5	70·4	·5	219	·5	367	,5	515	·5	663
10	74·1	30	222	50	370	70	519	90	667
·5	77·8	·5	226	·5	374	·5	522	·5	670
11	81·5	31	230	51	378	71	526	91	674
·5	85·2	·5	233	·5	381	·5	530	·5	678
12	88·9	32	237	52	385	72	533	92	681
·5	92·6	·5	241	·5	389	·5	537	·5	685
13	96·3	33	244	53	393	73	541	93	689
·5	100	·5	248	·5	396	·5	544	·5	693
14	104	34	252	54	400	74	548	94	696
·5	107	·5	256	·5	404	·5	552	·5	700
15	111	35	259	55	407	75	556	95	704
·5	115	·5	263	·5	411	·5	559	·5	707
16	119	36	267	56	415	76	563	96	711
·5	122	·5	270	·5	419	·5	567	·5	715
17	126	37	274	57	422	77	570	97	719
·5	130	·5	278	·5	426	·5	574	·5	722
18	133	38	281	58	430	78	578	98	726
·5	137	·5	285	·5	433	·5	581	·5	730
19	141	39	289	59	437	79	585	99	733
·5	144	·5	293	·5	441	·5	589	·5	737
20	148	40	296	60	444	80	593	100	741

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

This Table shows the number of cubic yards of Excavation, or Embankment, corresponding to different areas of cross section, and to a length of 100 feet. The areas are expressed in *square feet.*

This Table may be extended, by mentally changing the place of the decimal point; thus, the cubic yards corresponding to area of 1100 square feet will be 10 times that of 110 square feet, or 4074; those corresponding to an area of 8955 square feet will be 10 times that of 895·5 square feet, or 33167. If the number is not exactly divisible by 10, we may still take out the corresponding cubic yards with sufficient accuracy for practice, by using the nearest tabular number; thus, if we take 33167 for the cubic yards corresponding to an area of 8953 square feet, the error will be but about 8 cubic yards in 33000. A mean can, however, always be estimated in an instant by the eye, which will reduce the error to still less; thus it is seen at a glance, that 33157 is, in this instance, nearer than 33167.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
1	3·70	45	166·7	89	329·6	·5	431·5	·5	513·0	·5	594·4
2	7·41	46	170·4	90	333·3	117	433·3	139	514·8	161	596·3
3	11·1	47	174·1	91	337·0	·5	435·2	·5	516·7	·5	598·2
4	14·8	48	177·8	92	340·7	118	437·0	140	518·5	162	600·0
5	18·5	49	181·5	93	344·4	·5	438·9	·5	520·4	·5	601·9
6	22·2	50	185·2	94	348·2	119	440·7	141	522·2	163	603·7
7	25·9	51	188·9	95	351·9	·5	442·6	·5	524·1	·5	605·6
8	29·6	52	192·6	96	355·6	120	444·4	142	525·9	164	607·4
9	33·3	53	195·3	97	359·3	·5	446·3	·5	527·8	·5	609·3
10	37·0	54	200·0	98	363·0	121	448·2	143	529·6	165	611·1
11	40·7	55	203·7	99	366·7	·5	450·0	·5	531·5	·5	613·0
12	44·4	56	207·4	100	370·4	122	451·9	144	533·3	166	614·8
13	48·1	57	211·1	·5	372·2	·5	453·7	·5	535·2	·5	616·7
14	51·9	58	214·8	101	374·1	123	455·6	145	537·0	167	618·5
15	55·6	59	218·5	·5	375·9	·5	457·4	·5	538·9	·5	620·4
16	59·3	60	222·2	102	377·8	124	459·3	146	540·7	168	622·2
17	63·0	61	225·9	·5	379·6	·5	461·1	·5	542·6	·5	624·1
18	66·7	62	229·6	103	381·5	125	463·0	147	544·4	169	625·9
19	70·4	63	233·3	·5	383·3	·5	464·8	·5	546·3	·5	627·8
20	74·1	64	237·0	104	385·2	126	466·7	148	548·2	170	629·6
21	77·8	65	240·7	·5	387·0	·5	468·5	·5	550·0	·5	631·5
22	81·5	66	244·4	105	388·9	127	470·4	149	551·9	171	633·3
23	85·2	67	248·2	·5	390·7	·5	472·2	·5	553·7	·5	635·2
24	88·9	68	251·9	106	392·6	128	474·1	150	555·6	172	637·0
25	92·6	69	255·6	·5	394·4	·5	475·9	·5	557·4	·5	638·9
26	96·3	70	259·3	107	396·3	129	477·8	151	559·3	173	640·7
27	100·0	71	263·0	·5	398·2	·5	479·6	·5	561·1	·5	642·6
28	103·7	72	266·7	108	400·0	130	481·5	152	563·0	174	644·4
29	107·4	73	270·4	·5	401·9	·5	483·3	·5	564·8	·5	646·3
30	111·1	74	274·1	109	403·7	131	485·2	153	566·7	175	648·1
31	114·8	75	277·8	·5	405·6	·5	487·0	·5	568·5	·5	650·0
32	118·5	76	281·5	110	407·4	132	488·9	154	570·4	176	651·9
33	122·2	77	285·2	·5	409·3	·5	490·7	·5	572·2	·5	653·7
34	125·9	78	288·9	111	411·1	133	492·6	155	574·1	177	655·6
35	129·6	79	292·6	·5	413·0	·5	494.4	·5	575·9	·5	657·4
36	133·3	80	296·3	112	414·8	134	496·3	156	577·8	178	659·3
37	137·0	81	300·0	·5	416·7	·5	498·2	·5	579·6	·5	661·1
38	140·7	82	303·7	113	418·5	135	500·0	157	581·5	179	663·0
39	144·4	83	307·4	·5	420·4	·5	501·9	·5	583·3	·5	664·8
40	148·2	84	311·1	114	422·2	136	503·7	158	585·2	180	666·7
41	151·9	85	314·8	·5	424·1	·5	505·6	·5	587·0	·5	668·5
42	155·6	86	318.5	115	425·9	137	507·4	159	588·9	181	670·4
43	159·3	87	322·2	·5	427·8	·5	509·3	·5	5 ·7	·5	672·2
44	163·0	88	325·9	116	429·6	138	511·1	160	592·6	182	674·1

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	675·9	·5	783·3	·5	890·7	·5	998·2	·5	1105·6	·5	1213·0
183	677·8	212	785·2	241	892·6	270	1000·0	299	1107·4	328	1214·8
·5	679·6	·5	787·0	.5	894·4	·5	1001·9	·5	1109·3	·5	1216·7
184	681·5	213	788·9	242	896·3	271	1003·7	300	1111·1	329	1218·5
·5	683·3	·5	790·7	·5	898·2	·5	1005·6	·5	1113·0	·5	1220·4
185	685·2	214	792·6	243	900·0	272	1007·4	301	1114·8	330	1222·2
·5	687·0	·5	794·4	·5	901·9	·5	1009·3	·5	1116·7	·5	1224·1
186	688·9	215	796·3	244	903·7	273	1011·1	302	1118·5	331	1225·9
·5	690·7	·5	798·2	·5	905·6	·5	1013·0	·5	1120·4	·5	1227·8
187	692·6	216	800·0	245	907·4	274	1014·8	303	1122·2	332	1229·6
·5	694·4	·5	801·9	·5	909·3	.5	1016·7	·5	1124·1	·5	1231·5
188	696·3	217	803·7	246	911·1	275	1018·5	304	1125·9	333	1233·3
·5	698·2	·5	805·6	·5	913·0	·5	1020·4	·5	1127·8	·5	1235·2
189	700·0	218	807·4	247	914·8	276	1022·2	305	1129·6	334	1237·0
·5	701·9	·5	809·3	·5	916·7	·5	1024·1	·5	1131·5	·5	1238·9
190	703·7	219	811·1	248	918·5	277	1025·9	306	1133·3	335	1240·7
·5	705.6	·5	813·0	·5	920·4	·5	1027·8	·5	1135·2	·5	1242·6
191	707·4	220	814·8	249	922·2	278	1029·6	307	1137·0	336	1244·4
·5	709·3	·5	816·7	·5	924·1	·5	1031·5	·5	1138·9	·5	1246·3
192	711·1	221	818·5	250	925·9	279	1033·3	308	1140·7	337	1248·2
·5	713·0	·5	820·4	·5	927·8	·5	1035·2	·5	1142·6	·5	1250·0
193	714·8	222	822·2	251	929·6	280	1037·0	309	1144·4	338	1251·9
·5	716·7	·5	824·1	·5	931·5	·5	1038·9	·5	1146·3	·5	1253·7
194	718·5	223	825·9	252	933·3	281	1040·7	310	1148·2	339	1255·6
·5	720·4	·5	827·8	·5	935·2	·5	1042·6	·5	1150·0	·5	1257·4
195	722·2	224	829·6	253	937·0	282	1044·4	311	1151·9	340	1259·3
·5	724·1	·5	831·5	·5	938·9	·5	1046·3	·5	1153·7	·5	1261·1
196	725·9	225	833·3	254	940·7	283	1048·2	312	1155·6	341	1263·0
·5	727·8	·5	835·2	·5	942·6	·5	1050·0	·5	1157·4	·5	1264·8
197	729·6	226	837·0	255	944·4	284	1051·9	313	1159.3	342	1266·7
·5	731·5	·5	838·9	·5	946·3	·5	1053·7	·5	1161·1	·5	1268·5
198	733·3	227	840·7	256	948·2	285	1055·6	314	1163·0	343	1270·4
·5	735·2	·5	842·6	·5	950·0	·5	1057·4	·5	1164·8	·5	1272·2
199	737·0	228	844·4	257	951·9	286	1059·3	315	1166·7	344	1274·1
·5	738·9	·5	846·3	·5	953·7	·5	1061·1	·5	1168·5	·5	1275·9
200	740·7	229	848·2	258	955·6	287	1063·0	316	1170·4	345	1277·8
·5	742·6	·5	850·0	·5	957·4	·5	1064·8	·5	1172·2	·5	1279·6
201	744·4	230	851·9	259	959·3	288	1066·7	317	1174·1	346	1281·5
·5	746·3	·5	853·7	·5	961·1	·5	1068·5	·5	1175·9	·5	1283·3
202	748·2	231	855·6	260	963·0	289	1070·4	318	1177·8	347	1285·2
·5	750·0	·5	857·4	·5	964·8	·5	1072·2	·5	1179·6	·5	1287·0
203	751·9	232	859·3	261	966·7	290	1074·1	319	1181·5	348	1288·9
·5	753·7	·5	861·1	·5	968·5	·5	1075·9	·5	1183·3	·5	1290·7
204	755·6	233	863·0	262	970·4	291	1077·8	320	1185·2	349	1292·6
·5	757·4	·5	864·8	·5	972·2	·5	1079·6	·5	1187·0	·5	1294·4
205	759·3	234	866·7	263	974·1	292	1081·5	321	1188·9	350	1296·3
·5	761·1	·5	868·5	·5	975·9	·5	1083·3	·5	1190·7	·5	1298·2
206	763·0	235	870·4	264	977·8	293	1085·2	322	1192·6	351	1300·0
·5	764·8	·5	872·2	·5	979·6	·5	1087·0	·5	1194·4	.5	1301·9
207	766·7	236	874·1	265	981·5	294	1088·9	323	1196·3	352	1303·7
·5	768·5	·5	875·9	·5	983·3	·5	1090·7	·5	1198·2	·5	1305·6
208	770·4	237	877·8	266	985·2	295	1092·6	324	1200·0	353	1307·4
·5	772·2	·5	879·6	·5	987·0	·5	1094·4	·5	1201·9	·5	1309·3
209	774·1	238	881·5	267	988·9	296	1096·3	325	1203·7	354	1311·1
·5	775·9	·5	883·3	·5	990·7	·5	1098·2	·5	1205·6	·5	1313·0
210	777·8	239	885·2	268	992·6	297	1100·0	326	1207·4	355	1314·8
.5	779·6	·5	887·0	·5	994·4	·5	1101·9	·5	1209·3	·5	1316·7
211	781·5	240	888·9	269	996·3	298	1103·7	327	1211·1	356	1318·5

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	1320·4	·5	1427·8	·5	1535·2	·5	1642·6	·5	1750.0	·5	1857.4
357	1322·2	386	1429·6	415	1537.0	444	1644·4	473	1751·9	502	1859·3
·5	1324·1	·5	1431·5	·5	1538·9	·5	1646·3	·5	1753·7	·5	1861·1
358	1325·9	387	1433·3	416	1540·7	445	1648·2	474	1755·6	503	1863·0
·5	1327·8	·5	1435·2	·5	1542·6	·5	1650·0	·5	1757·4	·5	1864·8
359	1329·6	388	1437·0	417	1544.4	446	1651·9	475	1759·3	504	1866·7
·5	1331·5	·5	1438·9	·5	1546·3	·5	1653·7	.5	1761·1	·5	1868·5
360	1333·3	389	1440·7	418	1548·2	447	1655·6	476	1763·0	505	1870·4
·5	1335·2	·5	1442·6	·5	1550·0	·5	1657·4	·5	1764·8	·5	1872·2
361	1337·0	390	1444·4	419	1551·9	448	1659·3	477	1766·7	506	1874·1
·5	1338·9	·5	1446·3	·5	1553·7	·5	1661·1	·5	1768·5	·5	1875·9
362	1340·7	391	1448·2	420	1555·6	449	1663·0	478	1770·4	507	1877·8
·5	1342·6	·5	1450·0	·5	1557·4	·5	1664·8	·5	1772·2	·5	1879·6
363	1344·4	392	1451·9	421	1559·3	450	1666·7	479	1774·1	508	1881·5
·5	1346·3	·5	1453·7	·5	1561·1	·5	1668·5	·5	1775·9	·5	1883·3
364	1348·2	393	1455·6	422	1563·0	451	1670·4	480	1777·8	509	1885·2
·5	1350·0	·5	1457·4	·5	1564·8	·5	1672·2	·5	1778·6	·5	1887·0
365	1351·9	394	1459·3	423	1566·7	452	1674·1	481	1781·5	510	1888·9
·5	1353·7	·5	1461·1	·5	1568·5	·5	1675·9	·5	1783·3	·5	1890·7
366	1355·6	395	1463·0	424	1570·4	453	1677·8	482	1785·2	511	1892·6
·5	1357·4	·5	1464·8	·5	1572·2	·5	1679·6	·5	1787·0	·5	1894·4
367	1359·3	396	1466·7	425	1574·1	454	1681·5	483	1788·9	512	1896·3
·5	1361·1	.5	1468·5	·5	1575·9	.5	1683·3	·5	1790·7	·5	1898·2
368	1363·0	397	1470·4	426	1577·8	455	1685·2	484	1792·6	513	1900·0
·5	1364·8	·5	1472·2	·5	1579·6	·5	1687·0	·5	1794·4	·5	1901·9
369	1366·7	398	1474·1	427	1581·5	456	1688·9	485	1796·3	514	1903·7
·5	1368·5	·5	1475·9	·5	1583·3	·5	1690·7	·5	1798·2	·5	1905·6
370	1370·4	399	1477·8	428	1585·2	457	1692·6	486	1800·0	515	1907·4
·5	1372·2	·5	1479·6	·5	1587·0	·5	1694·4	.5	1801·9	·5	1909·3
371	1374·1	400	1481·5	429	1588·9	458	1696·3	487	1803·7	516	1911·1
·5	1375·9	·5	1483·3	·5	1590·7	·5	1698·2	·5	1805·6	·5	1913·0
372	1377·8	401	1485·2	430	1592·6	459	1700·0	488	1807·4	517	1914·8
·5	1379·6	·5	1487·0	·5	1594·4	·5	1701·9	·5	1809·3	·5	1916·7
373	1381·5	402	1488·9	431	1596·3	460	1703·7	489	1811·1	518	1918·5
·5	1383·3	·5	1490·7	·5	1598·2	·5	1705·6	·5	1813·0	·5	1920·4
374	1385·2	403	1492·6	432	1600·0	461	1707·4	490	1814·8	519	1922·2
·5	1387·0	·5	1494·4	·5	1601·9	·5	1709·3	·5	1816·7	·5	1924·1
375	1388·9	404	1496·3	433	1603·7	462	1711·1	491	1818·5	520	1925·9
·5	1390·7	·5	1498·2	·5	1605·6	·5	1713·0	·5	1820·4	·5	1927·8
376	1392·6	405	1500·0	434	1607·4	463	1714·8	492	1822·2	521	1929·6
·5	1394·4	·5	1501·9	·5	1609·3	·5	1716·7	·5	1824·1	·5	1931·5
377	1396·3	406	1503·7	435	1611.1	464	1718·5	493	1825·9	522	1933·3
·5	1398·2	·5	1505·6	·5	1613·0	·5	1720·4	·5	1827·8	·5	1935·2
378	1400·0	407	1507·4	436	1614·8	465	1722·2	494	1829·6	523	1937·0
·5	1401·9	·5	1509·3	·5	1616·7	·5	1724·1	·5	1831·5	·5	1938·9
379	1403·7	408	1511·1	437	1618·5	466	1725·9	495	1833·3	524	1940·7
·5	1405·6	·5	1513·0	·5	1620·4	·5	1727·8	·5	1835·2	·5	1942·6
380	1407·4	409	1514·8	438	1622·2	467	1729·6	496	1837·0	525	1944·4
·5	1409·3	·5	1516·7	·5	1624·1	·5	1731·5	·5	1838·9	·5	1946·3
381	1411·1	410	1518·5	439	1625·9	468	1733·3	497	1840·7	526	1948·2
·5	1413·0	·5	1520·4	·5	1627·8	·5	1735·2	·5	1842·6	·5	1950·0
382	1414·8	411	1522·2	440	1629·6	469	1737·0	498	1844·4	527	1951·9
·5	1416·7	·5	1524·1	·5	1631·5	·5	1738·9	·5	1846·3	·5	1953·7
383	1418·5	412	1525·9	441	1633·3	470	1740·7	499	1848·2	528	1955·6
·5	1420·4	·5	1527·8	·5	1635·2	·5	1742·6	·5	1850·0	·5	1957·4
384	1422·2	413	1529·6	442	1637·0	471	1744·4	500	1851·9	529	1959·3
·5	1424·1	·5	1531·5	·5	1638·9	·5	1746·3	·5	1853·7	·5	1961·1
385	1425·9	414	1533·3	443	1640·7	472	1748·2	501	1855·6	530	1963·0

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	1964·8	·5	2072·2	·5	2179·6	·5	2287·0	·5	2394·4	·5	2501·9
531	1966·7	560	2074·1	589	2181·5	618	2288·9	647	2396·3	676	2503.7
·5	1968·5	·5	2075·9	·5	2183·3	·5	2290·7	·5	2398·2	·5	2505·6
532	1970·4	561	2077·8	590	2185·2	619	2292·6	648	2400·0	677	2507·4
·5	1972·2	·5	2079·6	·5	2187·0	·5	2294·4	·5	2401·9	·5	2509·3
533	1974·1	562	2081·5	591	2188·9	620	2296·3	649	2403·7	678	2511·1
·5	1975·9	·5	2083·3	·5	2190·7	·5	2298 2	·5	2405·6	·5	2513·0
534	1977·8	563	2085·2	592	2192·6	621	2300·0	650	2407·4	679	2514·8
·5	1979·6	·5	2087·0	·5	2194·4	·5	2301·9	·5	2409·7	·5	2516·7
535	1981·5	564	2088·9	593	2196·3	622	2303·7	651	2411·1	680	2518·5
·5	1983·3	·5	2090·7	·5	2198·2	·5	2305·6	·5	2413·0	·5	2520·4
536	1985·2	565	2092·6	594	2200·0	623	2307·4	652	2414·8	681	2522·2
·5	1987·0	·5	2094·4	·5	2201·9	·5	2309·3	·5	2416·7	·5	2524·1
537	1988·9	566	2096·3	595	2203·7	624	2311·1	653	2418·5	682	2525·9
·5	1990·7	·5	2098·2	·5	2205·6	·5	2313·0	·5	2420·4	·5	2527·8
538	1992·6	567	2100·0	596	2207·4	625	2314·8	654	2422·2	683	2529·6
·5	1994·4	·5	2101·9	·5	2209·3	·5	2316·7	·5	2424·1	·5	2531·5
539	1996·3	568	2103·7	597	2211·1	626	2318·5	655	2425·9	684	2533·3
·5	1998·2	·5	2105·6	·5	2213·0	·5	2320·4	·5	2427.8	·5	2535·2
540	2000·0	569	2107·4	598	2214·8	627	2322·2	656	2429·6	685	2537·0
·5	2001·9	·5	2109·3	·5	2216·7	·5	2324·1	·5	2431·5	·5	2538·9
541	2003·7	570	2111·1	599	2218·5	628	2325·9	657	2433·3	686	2540·7
·5	2005·6	·5	2113·0	·5	2220·4	·5	2327·8	·5	2435·2	·5	2542·6
542	2007·4	571	2114·8	600	2222·2	629	2329·6	658	2437·0	687	2544·4
·5	2009·3	·5	2116·7	·5	2224·1	·5	2331·5	·5	2438·9	·5	2546·3
543	2011·1	572	2118·5	601	2225·9	630	2333·3	659	2440·7	688	2548·2
·5	2013·0	·5	2120·4	·5	2227·8	·5	2335·2	·5	2442·6	·5	2550·0
544	2014·8	573	2122·2	602	2229·6	631	2337·0	660	2444·4	689	2551·9
·5	2016·7	·5	2124·1	·5	2231·5	·5	2338·9	·5	2446·3	·5	2553·7
545	2018·5	574	2125·9	603	2233·3	632	2340·7	661	2448·2	690	2555·6
·5	2020·4	·5	2127·8	·5	2235·2	·5	2342·6	·5	2450·0	·5	2557·4
546	2022·2	575	2129·6	604	2237·0	633	2344·4	662	2451·9	691	2559·3
·5	2024.1	·5	2131·5	·5	2238·9	·5	2346·3	·5	2453·7	·5	2561·1
547	2025·9	576	2133·3	605	2240·7	634	2348·2	663	2455·6	692	2563·0
·5	2027·7	·5	2135·2	·5	2242·6	·5	2350·0	·5	2457·4	·5	2564·8
548	2029·6	577	2137·0	606	2244 4	635	2351·9	664	2459·3	693	2566·7
·5	2031·5	·5	2138·9	·5	2246·3	·5	2353·7	·5	2461·1	·5	2568·5
549	2033·3	578	2140·7	607	2248·2	636	2355·6	665	2463·0	694	2570·4
·5	2035·2	·5	2142·6	·5	2250·0	·5	2357·4	·5	2464·8	·5	2572·2
550	2037·0	579	2144·4	608	2251·9	637	2359·3	666	2466·7	695	2574·1
·5	2039·9	·5	2146·3	·5	2253·7	·5	2361·1	·5	2468·5	·5	2575·9
551	2040·7	580	2148·2	609	2255·6	638	2363·0	667	2470·4	696	2577·8
·5	2042·6	·5	2150·0	·5	2257·4	·5	2364·8	·5	2472·2	·5	2579·6
552	2044·4	581	2151·9	610	2259·3	639	2366·7	668	2474·1	697	2581·5
·5	2046·3	·5	2153·7	·5	2261·1	·5	2368·5	·5	2475·9	·5	2583·3
553	2048·2	582	2155·6	611	2263·0	640	2370·4	669	2477·8	698	2585·2
·5	2050·0	·5	2157·4	·5	2264·8	·5	2372·2	·5	2479·6	·5	2587.0
554	2051·9	583	2159·3	612	2266·7	641	2374·1	670	2481·5	699	2588·9
·5	2053·7	·5	2161·1	·5	2268·5	·5	2375·9	·5	2483·3	·5	2590·7
555	2055·6	584	2163·0	613	2270·4	642	2377·8	671	2485·2	700	2592·6
·5	2057·4	·5	2164·8	·5	2272·2	·5	2379·6	·5	2487·0	·5	2594·4
556	2059·3	585	2166·7	614	2274·1	643	2381·2	672	2488·9	701	2596·3
·5	2061·1	·5	2168·5	·5	2275·9	·5	2383·3	·5	2490·7	·5	2598·2
557	2063·0	586	2170·4	615	2277·8	644	2385.2	673	2492·6	702	2600·0
·5	2064·8	·5	2172·2	·5	2279·6	·5	2387·0	·5	2494·4	·5	2601·9
558	2066·7	587	2174·1	616	2281·5	645	2388·9	674	2496·3	703	2603·7
·5	2068·5	·5	2175·9	·5	2283·3	·5	2390·7	·5	2498·2	·5	2605·6
559	2070·4	588	2177·8	617	2285·2	646	2392·6	675	2500·0	704	2607·4

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	2609·3	.5	2716·7	·5	2824·1	·5	2931·5	·5	3038·9	·5	3146·3
705	2611·1	734	2718·5	763	2825·9	792	2933·3	821	3040·7	850	3148·2
·5	2613·0	·5	2720·4	·5	2827·8	·5	2935·2	·5	3042·6	·5	3150·0
706	2614·8	735	2722·2	764	2829·6	793	2937·0	822	3044·4	851	3151·9
·5	2616·7	·5	2724·1	·5	2831·5	·5	2938·9	.5	3046·3	·5	3153·7
707	2618·5	736	2725·9	765	2833·3	794	2940·4	823	3048·2	852	3155·6
·5	2620·4	·5	2727·8	·5	2835·2	·5	2942·6	·5	3050·0	·5	3157·4
708	2622·2	737	2729·6	766	2837·0	795	2944·4	824	3051·9	853	3159·3
·5	2624·1	·5	2731·5	·5	2838·9	·5	2946·3	·5	3053·7	·5	3161·1
709	2625·9	738	2733·3	767	2840·7	796	2948·2	825	3055·6	854	3163·0
·5	2627.8	·5	2735·2	·5	2842·6	·5	2950·0	·5	3057·4	·5	3164·8
710	2629·6	739	2737·0	768	2844·4	797	2951·9	826	3059·3	855	3166·7
·5	2631·5	·5	2738·9	·5	2846·3	·5	2953·7	·5	3061·1	·5	3168·5
711	2633·3	740	2740·7	769	2848·2	798	2955·6	827	3063·0	856	3170·4
·5	2635·2	·5	2742·6	·5	2850·0	·5	2957·4	·5	3064·8	·5	3172·2
712	2637·0	741	2744·4	770	2851·9	799	2959·3	828	3066·7	857	3174·1
·5	2638·9	·5	2746·3	·5	2853·7	·5	2961·1	·5	3068.5	·5	3175·9
713	2640·7	742	2748·2	771	2855·6	800	2963·0	829	3070·4	858	3177·8
·5	2642·6	·5	2750·0	·5	2857·4	·5	2964·8	·5	3072·2	·5	3179·6
714	2644·4	743	2751·9	772	2859·3	801	2966.7	830	3074.1	859	3181·5
·5	2646·3	·5	2753·7	·5	2861·1	·5	2968·5	·5	3075·9	·5	3183·3
715	2648·2	744	2755·6	773	2863·0	802	2970·4	831	3077·8	860	3185·2
·5	2650·0	·5	2757·4	·5	2864·8	·5	2972.2	·5	3079·6	·5	3187·0
716	2651·9	745	2759·3	774	2866·7	803	2974·1	832	3081·5	861	3188·9
·5	2653·7	·5	2761·1	·5	2868·5	·5	2975·9	·5	3083·3	·5	3190·7
717	2655·6	746	2763·0	775	2870·4	804	2977·8	833	3085·2	862	3192·6
·5	2657·4	·5	2764·8	·5	2872·2	·5	2979·6	·5	3087·0	·5	3194·4
718	2659·3	747	2766·7	776	2874·1	805	2981·5	834	3088·9	863	3196·3
·5	2661·1	·5	2768·5	·5	2875·9	·5	2983·3	·5	3090·7	·5	3198·2
719	2663.0	748	2770·4	777	2877·8	806	2985·2	835	3092·6	864	3200·0
·5	2664·8	·5	2772·2	·5	2879·6	·5	2987·0	·5	3094·4	·5	3201·9
720	2666·7	749	2774·1	778	2881·5	807	2988·9	836	3096·3	865	3203·7
·5	2668·5	·5	2775·9	·5	2883·3	·5	2990·7	·5	3098·2	·5	3205·6
721	2670.4	750	2777·8	779	2885·2	808	2992·6	837	3100·0	866	3207·4
·5	2672·2	·5	2779·6	·5	2887·0	·5	2994·4	·5	3101·9	·5	3209·3
722	2674·1	751	2781·5	780	2888·9	809	2996·3	838	3103·7	867	3211·1
·5	2675·9	·5	2783·3	·5	2890·7	·5	2998·2	·5	3105·6	·5	3213·0
723	2677·8	752	2785·2	781	2892·6	810	3000·0	839	3107·4	868	3214·8
·5	2679·6	·5	2787·0	·5	2894·4	·5	3001·9	·5	3109·3	·5	3216·7
724	2681·5	753	2788·9	782	2896·3	811	3003·7	840	3111·1	869	3218·5
·5	2683·3	·5	2790·7	·5	2898·2	·5	3005·6	·5	3113·0	·5	3220·4
725	2685·2	754	2792.6	783	2900·0	812	3007·4	841	3114·8	870	3222·2
·5	2687·0	·5	2794·4	·5	2901·9	·5	3009·3	·5	3116·7	·5	3224·1
726	2688·9	755	2796·3	784	2903·7	813	3011·1	842	3118·5	871	3225·9
·5	2690·7	·5	2798·2	·5	2905·6	·5	3013·0	·5	3120·4	·5	3227·8
727	2692·6	756	2800·0	785	2907·4	814	3014·8	843	3122·2	872	3229·6
·5	2694·4	·5	2801·9	·5	2909·3	·5	3016·7	·5	3124·1	·5	3231·5
728	2696·3	757	2803·7	786	2911·1	815	3018·5	844	3125·9	873	3233·3
·5	2698·2	·5	2805·6	·5	2913·0	·5	3020·4	·5	3127·8	·5	3235·2
729	2700·0	758	2807·4	787	2914·8	816	3022·2	845	3129·6	874	3237·0
·5	2701·9	5·	2809·3	·5	2916·7	·5	3024·1	·5	3131·5	·5	3238·9
730	2703·7	759	2811·1	788	2918·5	817	3025·9	846	3133·3	875	3240·7
·5	2705·6	5·	2813·0	·5	2920·4	·5	3027·8	·5	3135·2	·5	3242·6
731	2707·4	760	2814·8	789	2922·2	818	3029·6	847	3137·0	876	3244·4
·5	2709·3	·5	2816·7	·5	2924·1	·5	3031·5	·5	3138·9	·5	3246·3
732	2711·1	761	2818·5	790	2925·9	819	3033·3	848	3140·7	877	3248·2
·5	2713·0	·5	2820·4	·5	2927·8	·5	3035·2	·5	3142·6	·5	3250·0
733	2714·8	762	2822·2	791	2929·6	820	3037·0	849	3144·4	878	3251·9

TABLE 15.—CUBIC YARDS IN 100 FEET LENGTH.

Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.	Area. sq. ft.	Cubic Yards.
·5	3253·7	899	3329·6	·5	3405·6	940	3481·5	·5	3557·4	981	3633·3
879	3255·6	·5	3331·5	920	3407·4	·5	3483·3	961	3559·3	·5	3635·2
·5	3257·4	900	3333·3	·5	3409·3	941	3485·2	·5	3561·1	982	3637·0
880	3259·3	·5	3335·2	921	3411·1	·5	3487·0	962	3563·0	·5	3638·9
·5	3261·1	901	3337·0	·5	3413·0	942	3488·9	·5	3564·8	983	3640·7
881	3263·0	·5	3338·9	922	3414·8	·5	3490·7	963	3566·7	·5	3642·6
·5	3264·8	902	3340·7	·5	3416·7	943	3492·6	·5	3568·5	984	3644·4
882	3266·7	·5	3342·6	923	3418·5	·5	3494·4	964	3570·4	·5	3646·3
·5	3268·5	903	3344·4	·5	3420·4	944	3496·3	·5	3572·2	985	3648·2
883	3270·4	0·5	3346·3	924	3422·2	·5	3498·2	965	3574·1	·5	3650·0
·5	3272·2	904	3348 2	·5	3424·1	945	3500·0	·5	3575·9	986	3651·9
884	3274·1	·5	3350·0	925	3425·9	·5	3501·9	966	3577·8	·5	3653·7
·5	3275·9	905	3351·9	·5	3427·8	946	3503·7	·5	3579·6	987	3655·6
885	3277·8	·5	3353·7	926	3429·6	·5	3505·6	967	3581·5	·5	3657·4
·5	3279·6	906	3355·6	·5	3431·5	947	3507·4	·5	3583·3	988	3659·3
886	3281·5	·5	3357·4	927	3433·3	·5	3509·3	968	3585·2	·5	3661·1
·5	3283·3	907	3359·3	·5	3435·2	948	3511·1	·5	3587 0	989	3663·0
887	3285·2	·5	3361·1	928	3437·0	·5	3513·0	969	3588·9	·5	3664·8
·5	3287·0	908	3363·0	·5	3438·9	949	3514·8	·5	3590·7	990	3666·7
888	3288·9	·5	3364·8	929	3440·7	·5	3516·7	970	3592·6	·5	3668·5
·5	3290·7	909	3366·7	·5	3442·6	950	3518·5	·5	3594·4	991	3670·4
889	3292·6	·5	3368·5	930	3444·4	·5	3520·4	971	3596·3	·5	3672·2
·5	3294·4	910	3370·4	·5	3446·3	951	3522·2	·5	3598·2	992	3674·1
890	3296·3	·5	3372·2	931	3448·2	·5	3524·1	972	3600·0	·5	3675·9
·5	3298·2	911	3374·1	·5	3450·0	952	3525·9	·5	3601·9	993	3677·8
891	3300·0	·5	3375·9	932	3451·9	·5	3527·8	973	3603·7	·5	3679·6
·5	3301·9	912	3377·8	·5	3453·7	953	3529·6	·5	3605·6	994	3681·5
892	3303·7	·5	3379·6	933	3455·6	·5	3531·5	974	3607·4	·5	3683·3
·5	3305·6	913	3381 5	·5	3457·4	954	3533·3	·5	3609·3	995	3685·2
893	3307·4	·5	3383·3	934	3459·3	·5	3535·2	975	3611·1	·5	3687·0
·5	3309·3	914	3385·2	·5	3461·1	955	3537·0	·5	3613·0	996	3688·9
894	3311·1	·5	3387·0	935	3463·0	·5	3538·9	976	3614·8	·5	3690·7
·5	3313·0	915	3388·9	·5	3464·8	956	3540·7	·5	3616·7	997	3692·6
895	3314·8	·5	3390·7	936	3466·7	·5	3542·6	977	3618·5	·5	3694·4
·5	3316·7	916	3392·6	·5	3468·5	957	3544·4	·5	3620·4	998	3696·3
896	3318·5	·5	3394·4	937	3470·4	·5	3546·3	978	3622·2	·5	3698·2
·5	3320·4	917	3396·3	·5	3472·2	958	3548·2	·5	3624·1	999	3700·0
897	3322·2	·5	3398·2	938	3474·1	·5	3550·0	979	3625·9	·5	3701·9
·5	3324·1	918	3400·0	·5	3475·9	959	3551·9	·5	3627·8	1000	3703·7
898	3325·9	·5	3401·9	939	3477·8	·5	3553·7	980	3629·6		
·5	3327·8	919	3403·7	·5	3479·6	960	3555·6	·5	3631·5		

AMERICAN PATENTS.

List of American Patents which issued from July 15, *to August* 5, 1851, *(inclusive,) with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

18. For an *Improvement in Washing Machines;* John Boardman, Little Valley, New York, July 15.

Claim.—"I do not claim the constructing or using of a revolving wash barrel, with or without a rolling or tumbling pounder therein; but what I do claim, is the peculiar form of the revolving barrel with its fluted, semi-cylindrical recess, in combination with a pounding frame, constructed with a weighted hub and three parallel pounders, as herein described."

19. For an *Improvement in Securing Pinions, &c., of Watches in Lathes;* James M. Bottum, City of New York, July 15.

Claim.—"What I claim as my invention is, the employment of adhesive cement, for securing staffs and pinions of watches or time pieces for lathe operation, in combination with a chuck, a sliding tube, and a female centre, as described and set forth, or in any manner substantially the same."

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20. For an *Improvement in Machines for Cutting Wood into Shreds, and Crimping them for Mattrass Stuffing, &c.;* Edward K. Browning, Utica, New York, July 15.

Claim.—"What I claim as my invention, is the use of the splitters with the plane iron and the holder and the movable weighted lid, or any thing which is substantially the same, combined and arranged in the plane stock, for the purpose of producing the article herein described."

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21. For an *Improvement in Machines for Dressing Sisal Hemp, &c.;* Stillman A. Clemens, Springfield, Massachusetts, July 15.

Claim.—"What I claim as my invention is, the hinged jaw connected with the driving shaft, substantially as described, in combination with the cylinder to which it is hinged, and provided with a corresponding jaw, substantially as described, whereby the driving power in carrying around the substances to be dressed, clamps and holds them firmly, during the entire operation as described.

"And I also claim, in combination with the cylinder and clamp, for presenting and carrying around the substances to be dressed, as described, the knives and combs attached to one or more hinged bars, and provided with the necessary means for operating them, substantially as described.

"And I also claim, in combination with the cylinder as described, the vat of water in which at each rotation of the cylinder, the substances to be dressed, are immersed, substantially as described, and for the purpose specified."

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22. For an *Improvement in Churns;* Samuel G. Dugdale, Richmond, Indiana, July 15.

Claim.—"What I claim as my invention is, the application of the spring wire, which connects the crank with the dashers, in the manner and form, and for the purpose above set forth."

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23. For an *Improvement in Axle-Boxes for Journals for Railroad Cars;* Oliver N Trench, New London, Connecticut, Assignor to himself and Ebenezer Stevens, Hopkinton, New Hampshire, July 15.

Claim.—"What I claim as my invention, or improvement, is to support the case on the bearing by projections or analogous contrivances, applied to its sides, in combination with making the top plate of the case and the cap or side plate in one piece separate from the rest of the case, and holding them in place, by recesses and projections or analogous contrivances, substantially as described, the whole being to enable me to entirely dispense with the use of the screws or nuts in the construction of a railway car axle box, and thereby avoid, not only the injurious consequences which frequently result from their becoming loose, but also the necessity of that care and attention on the part of the car-man or attendant, so necessary when boxes are used, having any of their parts secured by screws."

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24. For an *Improvement in Carriage Springs;* Gustavus L. Haussnecht, New Haven, Connecticut, July 15.

Claim.—"What I claim as my invention, is the employment of a semi-elliptical spring in combination with a C spring, formed by the extension of one of the arms, the combined springs thus produced, being set transversely with the axle, and attached thereto and the body of the vehicle, in the manner substantially as shown and described."

25. For an *Improvement in Buggy Tops;* Harmon Hibbard, Assignor to Jared A. Hibbard, Henrietta, New York, July 15.

Claim.—"What I claim as my invention, is the mode of connecting carriage tops with the seats by means of bearers and clasp, so that they may, with facility, be removed from one carriage body, and applied to another, in the manner substantially as described."

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26. For an *Improvement in Fire Proof Safes;* Lewis Lallie, Assignor to John W. Bates, Troy, New York, July 15.

"The nature of my invention consists in constructing my safe in part of wrought and part of cast iron, which is without bolts, or rivets, as in the usual mode; my mode of construction being to render it more secure against burglary, by rendering it secure against being broke, or drilled into."

Claim.—"Having thus described the nature of my invention, what I claim as new, is the combination of wrought and cast iron, the same forming a safe, in the manner and for the purpose substantially the same as described."

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27. For *Improved Means for Adjusting the Effective Length of Bridge Counter-Braces;* D. C. McCallum, Owego, New York, July 15.

"My invention relates to the construction of open built beams, or guides, employed in bridges and other structures of a similar nature.

"My improvement consists in a new method of lengthening or shortening the counter-braces, whereby I am enabled to produce and maintain any required downward vertical strain or deflexion upon the girders; and which method I deem far more useful in practice, than those sometimes employed of using gibs, or keys, or wedges, for that purpose."

Claim.—"What I claim as my invention, is the method of lengthening or shortening the counter braces of a girder or bridge truss, so as to produce and maintain any desired vertical strain or deflexion, of the girder or truss, by means of the counter-brace, whether all of wood, or provided with a metallic end, or sheath, the plate of metal bearing upon the metallic end or sheath, (or upon the end of the wood, when the metallic end or sheath is not used,) at the top of the girder, and the nuts and the bolts passing through the clamping pieces, the upper chord and the posts, by which the plate of metal is drawn down upon the metallic end or sheath, and the adjustment of the length of the counter-brace effected, substantially as herein described."

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28. For an *Improved Rake to Harvesting Machines;* Sylvanus Miller, Urbana, Ohio, July 15.

"My invention has reference to the guidance and operation of the rake."

Claim.—"Having thus described the nature and construction of my harvesting apparatus, what I claim therein as new, is the guide, arranged as described in connexion with the tilting roller for the guidance of the rake, in a path similar to that which it would receive from the human hand, by which it removes periodically, the grain or grass from the bed, and frees itself, by the retraction of the teeth of the rake endwise."

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29. For an *Improved Arrangement of the Flues and Water Spaces of Steam Boilers;* William E. Milligan, Troy, New York, July 15.

"The nature of my invention consists in a new arrangement of flues and water spaces within a boiler for generating steam, whereby I am enabled to present a much enlarged amount of surface to the action of heat."

Claim.—"What I claim as of my own invention, is the general arrangement of the tubes and flues of the boiler, in the manner described; that is to say, the water tubes, connected with an upper and lower tube sheet in combination with the flues of less length than the tubes, which flues are also connected with an upper and lower flue sheet, whereby two horizontal flues are formed, in such connexion with each other, by means of the vertical flues, that the product of combustion from the fire-place, shall pass into the upper horizontal flue, and thence down the vertical flues, into the lower horizontal flue; having thus the facility of parting with its heat, on the one hand, by radiation through the flues to the water spaces surrounding them; and on the other, through the tubes, to

the water circulating through those; and this, whether the said tubes and flues are placed vertically or horizontally; the whole being constructed and operating substantially as herein set forth."

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30. For an *Improvement in Machines for Splitting Leather;* William Panton, Milton, Massachusetts, July 15.

Claim.—"I do not claim as my invention, in connexion with the upper feed roller, the use of a lower one, such as is usually termed a spring, or pressure roller, or one having a hard or practically inelastic surface; but what I do claim as my improvement in machinery for splitting, or dressing wet hides, is the employment of an elastic surface roller, (or roller made of gum elastic or other like material, placed around an axle or shaft,) and an inelastic roller, (as feed rollers,) in connexion with the cutting knife, made either stationary, or, what is better, to have a vibratory or reciprocating motion, all substantially as herein before specified."

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31. For an *Improvement in Molasses Gates or Faucets;* Erastus Stebbens, Chicopee, Massachusetts, July 15.

Claim.—"What I claim as my invention, is the arrangement of the spring, which bears the gate against the seat, said spring being arranged so as to bear against the outer edge, instead of the central part of the gate, in connexion with making the said gate separate from the lever, and to work on a projection or screw therefrom, essentially as specified."

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32. For an *Improvement in Revolving Breech Fire Arms;* James Warner, Springfield, Massachusetts, June 15.

"My invention consists in the engagement and disengagement of the barrel from the stock. This is effected with great facility in my improvement, by merely slackening up a screw in the stock, attached near the end of the back strap of the barrel, when a quarter revolution of the barrel will immediately release it from the stock."

Claim.—"What I claim as of my own invention, is the arrangement for securing the barrel to the stock, viz: the combination of the stud with the notch in the back strap, and with the notch and pin as described."

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33. For an *Improvement in Machines for Sawing and Dressing Staves;* Dennison Woodcock, Independence Centre, New York, July 15.

Claim.—"I do not claim the use of a cylindrical saw, as such has frequently been used, but what I do claim as my invention, is the employment of the saw, seated loose upon a pulley, so as to form an eccentric position with the same as specified, in combination with the cutters, the several parts constructed and operating together for the purposes set forth, substantially as shown and described."

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34. For an *Improvement in Brick Machines;* John J. Riddle, Covington, Kentucky, July 22.

"The object of my improvement in the manufacture of brick by machinery, is to bring and maintain an equal pressure upon all parts of the brick when in the mould, and thus to avoid a disturbance of the substance of any part subsequent to pressure, and the consequent liability to crack and separate."

Claim.—"Having thus fully described the nature and construction of my improvements in brick machines, what I claim therein as new, is the block or lip, substantially as described, hugging closely the mould wheel, immediately behind its point of contact with the pressure roller, in order to prevent any disturbance of the mass after having passed the point of contact."

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35. For an *Improvement in Combined Fountain and Evaporator;* George H. Thatcher, Albany, New York, July 22.

Claim.—"Having thus described my invention and improvement, of a self supplying evaporating fountain, what I claim therein as new, is constructing a vase, or other like

article, with two apartments or chambers, having a continuous as well as a periodical communication with each other, by which it is rendered a self-supplying, evaporating fountain, the continuous communication of the lower chamber with the upper apartment or evaporator, being effected by the pressure of steam upon the surface of the water in the lower chamber, and the periodical communication, by means of the valve secured in the screw-nut, which will be opened by the pressure of the accumulated water in the upper apartment, when relieved of the pressure of the steam in the lower chamber, as fully described and represented."

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36. For an *Improvement in the Mode of Changing Reciprocating into Rotary Motion;* Joel V. Strait, Litchfield, Ohio, July 22.

Claim.—"What I claim as my invention, is, 1st, the employment of curved or inclined forks, having a reciprocating rectilineal movement operating on or operated by cams, in the manner and for the purposes herein set forth.

"2d, The use of cams constructed or attached, so that they may be turned or set, in order to produce a change in direction of the motion, and acting in connexion with forks, or their equivalents, substantially for the purposes expressed, as shown and described."

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37. For *Improvements in Hanging Carriage Bodies;* John Jones, Clyde, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the manner herein described, of raising the body on to the springs, or lowering it on to the reaches, as may be desired, and for the purposes herein fully set forth."

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38. For an *Improvement in Buffing Apparatus for Daguerreotype Plates;* William and William H. Lewis, City of New York, July 22.

Claim.—"We do not claim heating the buffer, as that has been done by lamps, operating on the plate on which the buffing material is stretched; but in that form the heat is uneven and the vapor from the spirit lamp is liable to come in contact with the buffing material; but what we claim as new, and of our own invention, is the enclosing drum, constructed with the sliding segment, or cover, flanch, and lip, sliding in the grooved plate, and retained by the spring for the purposes specified, in combination with the drum, and pipe, to pass the heat from a spirit lamp, or other heater, to the drum, for the purpose of heating the buffer; the drum being fitted with a pipe or other means to pass any vapor from the spirit lamp outside the case enclosing the buffer, substantially as described and shown."

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39. For *Improvements in Hanging Carriage Bodies;* John Jones, Clyde, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new is, 1st, the combination herein described, of the turning compensating plate, with the rock shaft and the connecting rods, for the purpose of equalizing the action on the helical spring.

2d, I claim the stop lever in combination with the turning plate, used in fastening down the body, substantially in the manner herein described.

"3d, I claim the stays, for the purpose of keeping the axle trees in their true set, or upright position, as herein described and fully set forth."

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40. For an *Improvement in Faucets;* Charles W. Stearns, Springfield, Massachusetts, July 22.

Claim.—"What I claim therefore as my invention, is the application of a hollow conical packing around the waist of the valve stem, in combination with an open space between its lower end and the stem; the interior of the tubular projection being smooth, or of such form as to allow a tight joint between it and the conical packing, substantially as above described."

41. For an *Improvement in Saddle-Trees for Harness;* James A. Lawrence, Assignor to Roberts & Lampson, New Haven, Connecticut, July 22.

"The nature of my invention consists in constructing a pad-tree in such manner, that the pad-iron can be adjusted and secured at any required angle from the yoke, so as to fit easily the back of the horse on which it is placed."

Claim.—"I do not claim as my invention the yoke, the turrett, or the pad-iron, separate from each other; but what I do claim as my invention, is the combination and arrangement of the yoke, the turrett, and the pad-iron, in such manner that the pad-iron may be adjusted at any angle required for use, and immediately secured firmly in its place, by a screw on the terrett-iron, passing through the yoke into the pad-iron, substantially as shown in the drawings, and herein set forth."

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42. For *Improvements in Pumps for Raising Water, &c.;* Joseph F. Flanders Newburyport, Massachusetts, July 22.

Claim.—"What I claim as my invention or improvement, is as follows: I claim the rod, and its arms or other equivalent contrivances, and its valve collar, as applied to or combined with the rod of the lower box, and the valve or valves, made to operate therewith, substantially as above set forth."

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43. For an *Improvement in Cloth Folding Machines;* D. R. Ambrose, Portsmouth, New Hampshire, and O. L. Reynolds, Dover, New Hampshire, July 22.

Claim.—"What we claim as our invention, is the measuring and folding of cloth, paper, and other articles, by means of two revolving cylinders, each of which is provided with a tongue and jaws, the tongue to feed the cloth into the jaws, which seize it and form the fold and deliver it upon the table, leaving it properly measured and folded."

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44. For an *Improvement in Flour Bolts;* Samuel Cook, Adams' Basin, New York, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the combination and arrangement of the inclined boards, with a case of graduated screens, constructed and arranged substantially as herein described and represented, and for the purpose specially set forth."

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45. For an *Improvement in Parlor Cooking Stoves;* N. A. Boynton, Boston, Massachusets, July 22.

"My improvements consist in the arrangement of flues about the oven, by which the heat, smoke, &c., is made to pass about both the sides, and the top and bottom of said oven, the end or part of the oven most remote from the fire chamber, being heated, as well as the part adjacent to said fire chamber."

Claim.—"Having thus described my improvements in parlor cooking stoves, I shall state my claim as follows:

"What I claim as my invention, is the arrangement of flues, as herein above described, about the oven of a parlor cooking stove, by which the heat, smoke, &c., is first made to pass over the top of the oven, and then down the passage formed between the front side plate and the side of the oven, across the bottom of the oven, up through the passage formed between the rear side plate and the other side of the oven, and finally out through the smoke pipe; the heat, &c., being made to pass to the part of the oven most remote from the fire chamber, by the partitions on the top and bottom of said oven, substantially as herein above described."

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46. For an *Improvement in Mills for Grinding Corn and Cobs;* Sidney A. Bantz and William Andrew, Frederick, Maryland, July 22.

"Our mill is constructed to grind substances by means of toothed cylinders, which work in connexion with corresponding toothed concaves; and our improvement consists in a device, by means of which the substances introduced into the hopper, are chopped or broken into coarse fragments, and are then fed to the grinding apparatus."

Claim.—"What we claim as our invention is, the chopping and feeding apparatus, constructed and operating as herein described, in connexion with a grinding apparatus.

"We also claim the recess in the concave, which prevents the escape of fragments, when struck by the teeth of the cylinder."

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47. For *Improvements in Carriage Springs;* M. G. Hubbard, Rochester, New York, July 22.

"My improvement consists in forming a spring of a straight bar of steel, of proper dimensions, and equal thickness throughout, attaching it to the carriage so as to be compensating and self adjusting to any weight that the carriage is capable of sustaining, by which means I form a durable, cheap, and efficient spring of great lightness, that cannot be set or made to strike, when brought entirely down to its bearing."

Claim.—"Having thus fully described my improved spring reaches for carriages, what I claim therein as new, is the combination of the rockers and spring bars of a carriage, substantially as herein set forth, and for the purposes described."

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48. For *Improvements in Stave Dressing Machines;* William Hawkins, Milwaukie, Wisconsin, July 22.

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the arrangement for starting each stave, or introducing it to the feed at the proper moment, consisting of the wheel, with its stud, the bent lever, the pitman lever, shaft lever, sliding rod, spring, and adjustable starting bar, in combination with the apparatus for giving the reciprocating motion to the jointing cutters, so that the greatest width of the stave may be given on different lengths of stave uniformly at the middle, or such other point as may be desired; the whole being combined, arranged, and operated, in the manner substantially as herein specified."

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49. For an *Improved Machine for Dressing Boot Forms;* Joseph Burgess, Leicester, Massachussets, July 22.

Claim.—"What I claim as my invention is, the circular motion of the cutters attached to one end of a lever, the other end being so confined on the opppsite side of the boot form, as to allow the cutters to play up and down, and dress one or both sides of a boot form at a time, as herein set forth."

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50. For an *Improvement in Feather Edging Gauges for Shoemakers;* Jacob Jenkins, Andover, Massachusetts, July 22.

Claim.—"What I claim as my invention is, the arrangement of the adjustable gauge rest, the pressure roller and knife, or cutter, in the case or handle, substantially as described, and so as to constitute a tool for feather edging, or reducing soles of shoes, as specified."

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51. For an *Improvement in Bran Dusters;* Solomon W. Kirk, Coatesville, Pennsylvania, July 22.

Claim.—"I do not claim exclusively, the employment of intermediate vanes, acting in connexion with the brushes on the reel for forming a blast, as such have already been used; but what I do claim as my invention, is the employment of adjustable vanes, which may be set in or out, and obliquely in direction of their length, or be set either way only, as described and represented by the vanes lettered *f g* in the drawing; such adjustable vanes acting in combination with the brushes on the reel, for the purposes and in the manner substantially as set forth."

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52. For an *Improvement in Dyeing Door Mats;* Reuben Shaler, Madison, Connecticut, July 22.

"The nature of my invention consists in coloring the wool upon lamb skins, with a variety of colors upon each skin, or with one color on certain parts of the skin, leaving the remainder white. Either the colors or the white parts of the wool may be made to represent flowers, or any figures which the operator may design."

Claim.—"What I claim as my invention is, the coloring of borders and figures, in a

variety of colors and forms, upon the wool of lamb skins and sheep skins, for mats and other similar purposes, by the use of pans, (which are to contain the dyes,) being made and shapened in the form of the borders or figures designed to be colored, in combination with the matching tin or form, or an equivalent device for parting the wool, substantially in the manner and for the purpose herein set forth."

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53. For an *Improvement in Machines for Preparing Hubs for Boxes;* William R. Jones, Granville, New York, July 22.

Claim.—"Now what I claim as new, is the combination of the movable cutters with the saws and small pins, arranged and operating substantially in the manner and for the purpose herein described.

"I do not claim the cutter singly, or the arbor or disk, or the saw, such things having been used separately before."

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54. For an *Improved Method of Liberating Metal Tubes from Forming Mandrel;* Job Cutler, Birmingham, England, July 29; patented in England, February 28, 1849.

"My invention relates to improvements in the manufacture of metallic pipes or tubes, which have hitherto generally been brazed, or soldered, and cold drawn, and with a seam or joint."

Claim.—"Having now described the nature of my said invention, and in what manner the same is to be performed, I wish it to be understood, that I do not claim the exclusive use of the rolls for cross rolling, herein before described and represented, except when the same are employed in the manufacture of pipes or tubes of copper, brass, or other alloys of metal, as herein described, to be used as the flues of steam boilers; but what I do claim in the manufacture of pipes or tubes of brass, copper and alloys of metal, for the use as the flues of steam boilers, by rolling hot on a mandrel, whether parallel or taper, is the enlarging of them, by means of cross rolling, as above described, for the purpose of extracting the mandrel."

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55. For an *Improvement in Oil Cups for Journal Boxes;* Aaron Richardson, Bellows Falls, Vermont, July 29.

"My invention consists in providing the interior of the oil cup with a valve, which fits in a seat around the mouth, and is held there by a spring, serving to close the mouth of the cup, and exclude dirt, but yielding to the slightest pressure of the spout of an oil can or feeder, and allowing the oil or other lubricating material to be introduced, closing itself when the pressure is removed, and forming in fact a self acting stopple."

Claim.—"What I claim as my invention is, the employment within the mouth of an oil cup of a valve operated upon by a spring, or its equivalent, in the manner and for the purpose substantially as herein described."

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56. For an *Improvement in Fly Traps;* Harvey Snow, Lowell, Massachusetts, and Luther T. Smart, Campton, New Hampshire, July 29.

Claim.—"What we claim as our invention is, the tube in combination with the glass and the bottom, and rod, for the purpose above described, meaning to vary the construction while keeping the fixture substantially the same.

"We also claim the ring which is to close the apertures in the bottom, for the purpose to which it is applied, or any thing similar in its application."

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57. For an *Improvement in Cut-Off Gear;* George H. Corliss, Providence, Rhode Island, July 29.

Claim.—"In combination with the reciprocating motions communicated to the lifting rods, by the eccentric gear, I claim imparting a lateral movement to the free extremities of said lifting rods, to disconnect them from the valves, and permit the latter to close, to cut off the steam, or other expansive fluid, by which the engines may be driven, whereby these rods are made to perform their usual duty of opening the valves, and, in addition,

that of catches, or latches, in alternately connecting the valves with, and disconnecting them from, the mechanism by which they are opened, thus greatly simplifying the construction of the valve gear, rendering the same more durable and lesss liable to get out of order."

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58. For an *Improvement in Flexible Fences;* Matthias P. Coons, Lansingburg, New York, July 29.

"The nature of my invention consists in an improved mode of connecting and attaching panels of banister or picket fence, or railing, to each other and to a post; and, by the same device, the said fence or railing may be placed or erected on any and all grades of undulating surface, and all variations of course."

Claim.—"Having thus fully set forth and described the nature of my invention, and its practical operation, I do not claim any particular form or construction of a part in connexion herewith, the same not being essential; nor whether the same be of wood, or any other substance, (I having heretofore invented a metal post, being a convenient device to use in connexion herewith;) but what I do claim as my invention, is the form and construction of the two concave plates, with pins near their open ends, forming one coupling cap or clasp, for the purpose of uniting together the upper bars of fence or railing, whether the same be of wood or metal, and also, of securing the same by the use of a pin with a screw thereon, or other device, on the top of a post, in the manner and for the purpose as herein described.

"And in connexion therewith, I claim perforating the bars or rails, with conical or tapering holes, mortises or orifices, for the insertion of pickets or banisters, in the manner and all for the purpose as is herein substantially set forth and described."

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59. For an *Improvement in Cast Iron Car Wheels;* Thomas J. Eddy, Waterford, New York, July 29.

Claim.—"What I claim as my invention is, 1st, a cast iron car wheel, made with a hollow chilled rim, and hollow spokes, in the manner and form herein set forth.

"The method of forming wheels for railroad cars, by casting the rim and spokes upon a grooved hub, which has been formed separately, as herein described."

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60. For *Spring-Expanding Swage for Boiler Tubes, &c.;* James McCarty, Reading, Pennsylvania, July 29.

"My invention consists of an expanding swage, composed of sections, which are connected together and to a common centre, by spring shanks, in such manner, that while the several sections preserve their relative angular positions, they may be forced outwards from the axis of the tool, by means of a conical plug, so as to expand a tube in which the tool is inserted."

Claim.—"What I claim as my invention, is an expanding swage, constructed as herein set forth, and consisting, essentially, of radiating sections, which are connected with each other, and to a common centre, by spring shanks, as herein described."

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61. For an *Improved Powder Proof Bank Lock;* Wm. Hall, Boston, Massachusetts, July 29.

Claim.—"Having thus described my improvements in locks, I shall state my claim as follows: what I claim as my invention, is moving the key-bit to the tumblers by means of a follower, sliding between walls, as herein described, which follower acts in such a manner as to close the space into which powder might be introduced, where this is combined with a key hole cover, sliding as described, by which combination I make a powder proof lock, with tumblers, which cannot be reached by a pick, and whose slide cannot be blown off, so as to secure access to the tumblers.

"I also claim the combination with the plate of the transverse sliding vertical slotted plate, which jointly cut off all communication with the tumblers, in every position of the bolt."

62. For an *Improvement in Window Sashes;* Sewall Short, New London, Connecticut July 29.

"My improvement consists in so constructing the bars of the sash, as to enable me readily to set a pane or panes of glass without putty, and in a manner perfectly water-tight; the process being so simple, that any person can readily perform it; thus saving all the labor and expense of glazing in the ordinary way, or removing the sash from its place for the purpose."

Claim.—"Having thus fully described my improved method of setting glass, what I claim therein as new, is fastening the bars of two parts, as herein described, by binding them together by a screw at the junction of their ends, their opposite ends being hooked into the frame of the sash, substantially in the manner and for the purpose set forth, and in combination with this device, I claim the elastic bed for the glass to rest against, as above specified."

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63. For an *Improvement in Machines for Grinding Flock;* John C. Fonda, Albany, New York, July 29.

Claim.—"I do not limit myself to grinding or cutting flock, but any article to which the machine can be advantageously applied. I claim a cylinder, or drum, with knives or beaters attached, extending its length, said knives being set at an oblique angle, both with the radial lines and the axis of the drum, in combination with an outer cylinder, within which the drum revolves; the outer cylinder also revolving in an opposite direction, and having on its inner surface at intervals, knives extending its length, the said knives being parallel with its axis, but oblique to its radius; said outer cylinder also having in the intervals between its knives, panels containing projecting ribs, oblique to its axis, and so arranged that the action of the revolving knives upon any material lying between the ribs, shall gradually carry it from the inner to the outer end of said cylinder; thus subjecting the material to repeated cuttings between the revolving knives, substantially as set forth in the above specification.

"I claim the method of constructing the outer cylinder of alternate panels; the one set being permanent, and having on its inner surface, oblique ribs, the other set being movable and adjustable, (these panels are called cross bars in above description,) by screws and springs, and having on its inner surface, oblique knives; the fixed panels being connected with an outer and concentric ring of metal, by chambers or passages, the same being in combination with another cylinder or ring of metal, within which it fits and revolves, which last ring has a hopper upon it, to receive the material to be operated on, opening into the said chambers or passages, and by them into the cylinder containing the knives, substantially as set forth in the above specification.

"I claim the combination of outer and inner rings, with the inner and outer revolving cylinders and their knives and ribs, making a machine for grinding flock, or any other material, substantially as set forth and described in the above specification."

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64. For *Improvements in Knitting Machines;* John Henry Barsantee, Portsmouth, New Hampshire, July 29.

"The principal part of my improvements consists in the movable yarn carriers, which are made separate and independent, one for each needle, and having a sliding motion given to them in and out, they perform the part of the "jacks" in ordinary stocking looms."

Claim.—"Having thus described my improvements, what I claim as new therein, is, 1st, the sliding independent yarn carriers, each governing an independent thread for each needle, substantially in the manner and for the purpose as described.

"2d, I claim operating the yarn carriers, simultaneously, by means of the conical ring, working in the inclined slit in the carriers, substantially as set forth."

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65. For an *Improvement in Stoves with Portable Ovens;* George H. Thatcher, Albany, New York, July 29.

"The nature of my improvements consists in constructing a portable oven with a continuous flue, in such a manner as to unite with the fire chamber of the stove, and receive the heat therefrom, and conduct it over the top and down the rear side of the same, and permit it to pass thence into the upper flue, in the usual manner."

Claim.—"Having thus described my improvements in the portable oven, for cooking

stoves, what I claim therein as new, is in combination with a portable oven, the permanent damper plate, or shut off, which forces the heat and smoke, after striking against the bottom of the oven, to pass up the front flue and over the oven, and then down the back, passing down behind the permanent damper plate or shut off, and out through the ordinary draft, or top flue of the stove; being so simple in its construction, that it may be made by an ordinary tin-man, to suit any ordinary stove, as described and represented."

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66. For an *Improvement in Seeding Apparatus of a Seed Planter;* David Horner, Knox County, Ohio, July 29.

"My improvements have reference to two objects; first, to the equable distribution of manure; and second, to the certain and equable distribution of seed."

Claim.—"What I claim as my invention, is the combination of the measuring seed roller with the distributing seed roller, the two being arranged and operated in the manner and for the purpose herein described."

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67. For an *Improvement in Machines for Preparing Hubs for the Reception of Boxes;* Henry Moore, Seneca County, Ohio, July 29.

"The nature of my invention consists in providing an auger, and box-setter, for the purpose of boring the hubs and setting the boxes of wagon, carriage, railway car, and other vehicle wheels."

Claim.—"What I claim as my invention, is the sliding shaft, with the slot marked, passing longitudinally into the mandrel, together with the screw thread cut upon the mandrel to feed the knives, and the knives, which are so adjusted as to act at both ends at the same time, and also cross stays, similar in construction (which may be formed of wood,) to those marked 1 and 2 in the above description, which are intended for the purpose of fastening and truing the hub; all of which will appear by the above description, except the cross stays, for the purpose of securing and truing the hub, during the process of boring."

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68. For *Improved Fittings for Boats, to Facilitate the Discharge of Cargo, &c.;* Willlam H. Bryan, Georgetown, D. C., July 29.

Claim.—"What I claim as my invention, is the cargo deck, formed of loose, narrow sections, so that it may be removed, to adapt the vessel to carrying cargo in packages, or may be put in place, to facilitate the unlading of cargo in bulk, in combination with the railway on the floor, for transporting the lading to the point whence it is removed from the hold."

Re-issues for July, 1851.

1. For an *Improvement in Steam and Vacuum Gauges;* Paul Stillman, City of New York; patented May 9, 1848; re-issued July 29, 1851.

Claim.—"What I claim as my invention, is, 1st, the combining with the reservoir of mercury at the lower end of the tube, an elevated chamber forming part of the reservoir substantially as herein described; so that the zero point may be high enough to be visible above the reservoir as herein described, and also that the air contained in the tube being condensed by the pressure of the mercury in the elevated chamber, may furnish more desirable divisions on the scale, when very high pressures are to be indicated.

"2d, The producing a partial vacuum in the tube of the steam gauge at the time of filling it with mercury, for the purpose of bringing the zero point high enough to be visible above the reservoir, and also in order to prevent any partial vacuum produced in the boiler from drawing all the mercury out of the tube.

"3d, Surrounding the lower end of the glass tube with a metallic cylinder, provided with a cap or plug at its lower end for protecting the glass tube, and allowing the mercury only to pass slowly, either through a very small hole or between the threads of the screw, and the establishing a connexion between the reservoir and the boiler, substantially in the manner and for the purpose above specified.

"4th, The method of preventing the air or moisture from passing between the mercury and the cylinder into the tube, either by turning the cylinder or washing it with mercury, or by plunging it deeply into the mercury as above described.

"5th, Preventing the inside of the tube from being soiled with oxidised mercury, by either placing on the surface of the mercury in the tube some fluid (such as naphtha) which does not act perceptibly upon mercury, or by filling the tube with gas as herein made known."

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2. For *Improvements in Fastenings of Scythes to the Snath;* E. S. Clapp, Montague, Massachusetts; patented March 18, 1851; re-issued July 8, 1851.

Claim.—"What I claim as my invention, is, 1st, the mode of attaching and securing the blade of the scythe to the snath, substantially as herein specified, to wit: by clamping its shank between the edges of an aperture, in the end of a metal cap secured to the snath, and two bearings or points on the opposite side of the shank, and on opposite sides of the first named bearing point, one of the two bearings consisting in a screw or its equivalent, for the purpose of giving the necessary pressure to clamp it.

"2d, The method substantially as herein described, of setting the edge of the blade more up or down, by means of the adjusting screw, in combination with the edge of the aperture, which forms one of the three bearing points of the shank."

Designs for July, 1851.

1. For a *Design for Cooking Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental figures and forms, represented in the accompanying drawings, forming together the ornamental designs for the plates of a cooking stove."

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2. For a *Design for Stoves;* William C. Davis, Cincinnati, Ohio, July 8.

Claim.—"Having described and represented my ornamental design for stoves, I wish it to be understood that I do not claim the radiating ornaments or the mouldings, separately considered, but what I do claim, is the combination of the ornaments as described and represented."

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3. For a *Design for Parlor Stoves;* Joseph Pratt, Boston, Massachusetts, July 8.

Claim.—"Having thus described my new design, I shall state my claim as follows: I claim the design consisting of the ornamental configuration, flower and leaf work herein above described and represented in the drawings, respectively, for the top and bottom plates of a parlor stove."

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4. For a *Design for Water Coolers;* William Burnet, Cincinnati, Ohio, July 8.

Claim.—"What I claim as my design, is, 1st, the form and general configuration of the outer casing, substantially as described and represented in the drawings.

2d, The dolphin spout, and, 3d, the configuration of the handle of the cover, substantially as shown."

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5. For a *Design for Stoves;* James V. De Witt, Buffalo, New York, July 8.

Claim.—"What I claim as new, is the design and configuration of ornamental stove plates, as herein described and represented in the annexed drawings."

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6. For a *Design for Stoves;* S. W. Gibbs, Albany, New York, Assignor to North, Harrison & Chase, Philadelphia, Pennsylvania, July 8.

Claim.—"What I claim as my invention is the arrangement of the ornaments and mouldings herein described, as constituting a design for cooking stoves."

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7. For a *Design for Plates of Franklin Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production is the combination and arrangement of ornamental figures and forms represented in the accompanying drawings, forming together the ornamental designs for the plates of a Franklin stove."

8. For a *Design for Cooking Stoves;* John F. Rathbone, Albany, New York, July 8.

Claim.—"What I claim as my production, is the combination and arrangement of ornamental figures and forms, represented in the accompanying drawings, forming together the ornamental designs for the plates of a cooking stove."

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9. For a *Design for Stove Plates;* Elijah P. Penniman, Rochester, New York, July 15.

Claim.—"What I claim as my invention, is the ornamental design or production represented by figures 2 and 4, and to be used with the carving represented by letters O P."

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10. For a *Design for Stove Plates;* Elijah P. Penniman, Rochester, New York, July 15.

Claim.—"What I claim as my invention, is the ornamental design or production, represented by figures 1 and 3, to be used with the carving represented by letter N."

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11. For a *Design for Plates of Parlor Stoves;* Apollos Richmond, Assignor to A. C. Barston & Co., Providence, Rhode Island, July 15.

Claim.—"Having thus described my new design, I shall state my claim as follows: I claim the design, consisting of the ornamental arches, panels, and mouldings, herein above described and represented in the drawing respectively, for the front and top plates of a parlor stove."

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12. For a *Design for Cast Iron Tomb;* Henry K. Flinchbaugh, Conestoga, Pennsylvania, July 22.

Claim.—"What I claim as my invention, is the ornamental design for cast iron "Cemetery Tomb," ornamented as herein described."

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13. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental designs for ornaments upon cast iron stove plates above described, and more fully shown in the annexed drawings."

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14. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental design for cast iron stove plates, shown in the annexed drawings and above described."

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15. For a *Design for Stoves;* Reuben J. Blanchard, Assignor to B. P. Learnard and G. H. Thatcher, Albany, New York, July 29.

Claim.—"What I claim as my invention, is the ornamental design above described and delineated in the annexed drawings, as an ornament for the plates of cast iron stoves."

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16. For a *Design for Stoves;* Nicholas S. Vedder, Assignor to A. T. Dunham & Co., Troy, New York, July 29.

Claim.—"What I claim, is the design and configuration of ornaments as applied to stoves, substantially the same as described."

AUGUST.

1. For an *Improvement in Tight Joint for Tuyeres;* Wm. Graham, Carlisle, Pennsylvania, August 5.

"The nature of my invention consists in the arrangement of the inner and outer beads on the top plate, between which is placed clay, or other plastic material, and the grooves in the edges of the sides of the tuyere, for the purpose of making an air tight joint; the

whole being secured by bolts with projections upon them, catching over a cam cast on the flanches, on the under plate."

Claim.—"Having thus fully described my invention, what I claim therein as new, is, the combination of the inner and outer beads on the top plate, between which is placed clay, or other plastic material, and the grooves in the edges of the sides of the tuyere, for the purpose of making an air tight joint; the whole being secured by bolts, with a projection on them, catching over a cam cast on flanches on the under plate, as herein described and represented."

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2. For an *Improvement in Brick Machines;* Luther Brown, Canandaigua, New York, August 5.

"The object of my improvement is to produce a portable brick machine, which can be worked either by hand or horse power, and one which will require but few hands to manage, and at the same time do its work rapidly and well."

Claim.—"Having thus described my improvements, what I claim as new therein, is, 1st, the arrangement of the apparatus for moving the moulds and the pressing apparatus, all constructed substantially as herein described, and worked by the revolving shaft in the manner and for the purposes set forth."

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3. For an *Improvement in Grain Winnowers and Harvesters;* Augustus P. Childs, Rochester, New York, August 5.

"The object of my improvement is to effect the more thorough separating and cleansing of grain from the straw and impurities with which it is mingled, when discharged from a threshing machine, and also to simplify the construction of the apparatus, as well as to increase its efficiency."

Claim.—"I claim the elevator, constructed substantially as herein set forth, with oblique plates or blocks, to support the straw, and facilitate the separation of the grain.

"I also claim the arched grating, in connexion with a blast, to effect the separation of the lighter impurities from the grain.

"I likewise claim the arrangement, substantially as herein described, of the air chamber between the fans, the suction pipe to supply the chamber with air, and the spout to conduct the once winnowed grain from the screw into the lower extremity of the suction pipe, to be winnowed a second time by the entering current of air, whereby the grain is subjected to the full force of two independent blasts, acting consecutively, which insures its effectual winnowing, as herein set forth."

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4. For an *Improvement in Brick Machines;* James Dane, Darius Healy, and Garry Cumings, Assignors to Isaac and Francis Dane, Derby, Vermont, August 5; antedated, June 17, 1851.

Claim.—"What we claim as our invention, is, 1st, the arrangement of mechanism, substantially as herein described, viz: the toothed wheel, and the cams operated by the changing gear or the equivalent thereof, connected with the mill, so as to be moved alternately back and forth, for the purpose of operating the mould carriage and the pressing piston, substantially in the manner herein set forth.

"2d, We also claim the adjustable rod or its equivalent, connected with the piston rod for the purpose of acting upon the catch lever, or its equivalent, so as to disengage the weight or its equivalent, by which the operating machinery is thrown out of gear, for the purpose of arresting the pressing motion as soon as the piston has been depressed far enough to fill the moulds.

"3d, Is the circular projection or its equivalent, upon the wheel, to throw the wheel out of gear, and stop the moulding apparatus, while the grinding proceeds."

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5. For an *Improvement in Dressing Mill-Stones;* Moore Holden, Lawrenceburgh Indiana, August 5.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction and operation of my invention, being an improvement in dressing millstones, what I claim therein as new, is, the dress given to millstones, according to the definite and fixed rules

described in the foregoing specification, and illustrated in the drawing by the furrows of each quarter.

"I also claim diminishing the draft of the runner, and increasing the number of the quarters, in comparison with that given the bed stone, for the purpose of giving the furrows of each stone, as determined by the rule laid down in the specifications, a shears motion upon each other."

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6. For an *Improved Water Level Indicator for Steam Boilers;* Albert H. Jadd, Marinetown, Illinois, August 5.

Claim.—"What I claim as my invention is, the connecting the ordinary float, placed within a steam boiler, with an index placed on the outside of the same, through the medium of the valve of a gauge-cock, by which I am enabled to remove any impurities which may at any time hinder the effective action of the float, substantially as herein set forth."

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7. For an *Improvement in Shutters for Shop Fronts;* James Root, Cincinnati, Ohio, August 5.

Claim.—"Having thus fully described my improved shutter, what I claim therein is, in combination with the sliding shutter, substantially as above described, the door, by which it is fastened, and which permits it to slide back."

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8. For an *Improvement in Metallic Alloy Paints;* Charles Wetterstedt, Marseilles, France, Assignor to Charles Keenan, City of New York, August 5; patented in England, Nov. 3, 1846.

"The basis of my invention consists in the combination or mixture of regulus of antimony, in various proportions, purified from all ferruginous particles, with copper, tin, zinc, or lead. These mixtures reduced to impalpable powders, are combined with suitable vehicles to form paint, and spread on the surfaces to be preserved."

Claim.—"Having thus described my invention, what I claim as new is, making paints out of metallic antimony, whether prepared separately, or combined with other metals, to form alloys suitable for making paints, substantially as herein set forth.

"2d, I also claim combining antimonial alloys with oxide of copper, to constitute with the painting vehicles herein specified, the exterior coatings for ships' bottoms, for the purpose of more effectually defending them against the adhesion of shells and weeds, substantially as herein set forth."

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9. For an *Improvement in Hot Air Furnaces;* Joseph C. Treat, East Hartford, Connecticut, August 5.

Claim.—"What I claim as my invention, is the employment of a flue or chamber, having a valve and apertures, in combination with an internal flue, constructed and operating substantially as shewn and described for the purposes set forth."

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10. For an *Improvement in Quadrant Hinged Grates;* George H. Thatcher, Albany, New York, August 5.

Claim.—"What I do claim as new and of my own invention, is suspending the quadrant grate by pivots projecting from the ends thereof, near the centre of the circle of the grate, in such a manner, that when it shall be desired to discharge the contents from the grate, its rear and lower portion will be made to recede from the back wall and rise in the throat of the chimney, and thus the contents will be discharged into the rear portion of the fire place, and the dust carried directly up the chimney, and the grate moving outward, having to drag through the accumulated coal, ashes, &c., in the fire place, as described.

"I also claim the combination of the guard plate with the quadrant grate, said guard plate projecting from the back of the fire place horizontally above the lower rear edge of the grate, and vertically within the ends of the same, for the double purpose of forming a support for the fire brick, or back of the grate, and protecting the inner edges of the bottom and ends of the grate, and preventing it from being opened by the lumps of coal,

that would otherwise fall between its edges and back wall, and force the grate open as described."

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11. For an *Improvement in Shuttle Motions of Looms;* George J. Wardwell, Hanover, Maine, August 5.

Claim.—"What I claim as my invention is, operating the picker staff or staves, by a cam or cams, upon a shaft, hung in bearings, attached to the lay, and carrying a ratchet wheel, which receives motion, at suitable intervals, through an arm, worked by the same motion which operates the lay, substantially in the manner herein described."

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12. For an *Improvement in Machines for Taking Ayes and Noes;* G. William Yerby, Washington, District of Columbia, August 5.

Claim.—"Having thus fully described my improvements, what I claim therein as new, is the peculiar form and action of the springs which carry the pencil, by which a draw mark is made, without risk of breaking the point."

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13. For an *Improvement in Working Clay for Pottery and other Ware;* John Akrill, Williamsburgh, New York, August 5.

Claim.—"Therefore, what I claim as my invention, is the application of heat to clay, during the process of mixing, working, and tempering the clay, so that it is raised to a heat at or about the boiling point of water, at the time of moulding or forming the same, substantially as described and shown."

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14. For an *Improvement in Looms for Weaving Pile Fabrics;* John Johnson, Assignor to Elias Johnson, Troy, New York, August 5.

Claim.—"Having thus set forth the principle of my invention, and the manner of constructing and using the same, I wish it to be understood, that I do not limit myself to the special construction and arrrangement of parts herein specified, as these may be varied, without changing the principle or mode of operation; what I claim as my invention, is the employment on one or both sides of the loom of two carriers, to which the figuring wires are secured, and two guides, substantially as described, and operated alternately; the said carriers having a motion towards and from the selvedge of the cloth, to draw out and insert the wires, and together with the guides, a motion towards and from the lay, to carry the wires from the woven pile to the open shed and back, as described.

"And I also claim, in combination, giving to the guides a vertical movement, after the wire has been drawn out, to admit of their passing each other, substantially as specified."

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15. For an *Improvement in Sewing Machines;* Wm. H. Akins and Jacob D. Felthousen, Ithica, New York, August 5.

Claim.—"Having thus fully described our invention, what we claim therein as new, is, 1st, the combination and arrangement of the pitman, driving bar, shuttle, and adjustable set screw, for the purpose of allowing the pitman a continuous motion, whilst the shuttle bar and shuttle is momentarily stopped, to allow the needle to draw up the stitch, as herein described and represented.

"2d, We claim bringing up the needle with a sudden jerk, after the stitch is formed, for the purpose of tightening up the stitch, after the manner of hand sewing, and adjusting the same to any thickness of material to be sewn."

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16. For an *Improvement in Looms for Weaving Cut Pile Fabrics;* Mertoun C. Bryant, Lowell, Massachusetts, August 5.

"The first part of my invention consists of a method of holding and supporting the warp threads, in order that the filling may be properly drawn in at the edges of the cloth to make smooth selvedges.

"The second part of my invention consists of a method of holding the filling thread in the place where it is left by the reed, when it is beaten up into the cloth.'

Claim.—"What I claim as my invention, is 1st, the use in looms, of a finger or shield, which shall be introduced between the warps, for the purpose of bringing the warp threads at the edge of the cloth, in such a position, that the filling yarn will be drawn in to form a smooth selvedge, substantially as described.

"2d, The use of hooks, formed on the intersecting plates, or their equivalents, which shall hold the filling thread from returning towards the reed, substantially as described."

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17. For an *Improvement in Brick Machines;* Isaac Gregg, Pittsburg, Pennsylvania, August 5.

Claim.—"What I claim as my invention, is the placing the auxiliary pressure roller, or its equivalent, between the main roller and the knife, for the purpose of subjecting the surplus clay, after it is elevated above the tops of the moulds, to the action of pressure, before removing the same by the said knife, substantially as herein set forth.

"I also claim the subjecting the upper surface of the clay in each mould, to a rubbing pressure by means of a plate or its equivalent, placed above the tops of the moulds, in combination with some mechanical device for forcing up the movable bottoms of the said moulds, whilst passing under the said plate, substantially in the manner and for the purpose herein set forth."

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18. For an *Improvement in Printing Presses;* George P. Gordon, City of New York, August 5.

"The nature of my invention consists in arranging a platen, which vibrates upon a centre, so as to carry the face in an arc of a circle, to and from the points or places of receiving the sheet of paper and the impression at the proper times; also in adapting the same to receive the sheet of paper between said platen, and a frisket with adjusting nippers; as well as a proper arrangement of bed, inking rollers, etc., all of which is hereinafter fully described and set forth."

Claim.—"What I claim as my invention, is, 1st, giving to the platen a rotating, reciprocating motion, which enables it to assume the two positions of receiving the sheet and the impression alternately, when operated by the cam, sectional arm, and its own segment, geared with the segment of the sectional arm, by giving to it the movement described of an arc of the circle, when traversing from one of these positions to the other.

"2d, I claim affixing the vibrating bed on its own axis, so that it may recede into the proper position for receiving the inking rollers for inking the form, and become perpendicular, and directly face to face with the platen, when the toggle is straight, for the purpose of giving the impression.

"3d, I claim the arrangement of two side arms, so combined as to form a frame to hold and carry the inking rollers, and giving to them the motion, both forward and backward, over the form, for each impression, during the rest of the other parts; whether the same be done in this precise manner or equivalents to produce a like result.

"4th, I claim the grooved cam shaped arms or guides, or their equivalents, for the purpose of carrying the frisket in the right direction, and holding it in the desired position, during the intervals of rest given to the platen, that is, opening it to relieve the printed sheet, and holding it open to lay the succeeding sheet, and closing it firmly against the platen, to grip the sheet, and holding it closed until the bed has moved forward, given the impression, and receded to its original position.

"5th, I claim the combination of the bed, vibrating on its own axis, with the roller frame composed of two arms, substantially as herein described and set forth."

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19. For an *Improved Spring Bolt;* Oliver H. Bush, Fall River, Massachusetts, August 5.

Claim.—"What I claim as my improvement, is the combination of the lever with the spring bolt and its case, so as to operate therewith, substantially in the manner as specified."

On Steam Boilers and the Causes of their Explosion. *By* W. Fairbairn, Esq., C. E., F. R. S., &c.*

Continued from page 138.

1*st. Boiler Explosions arising from accumulated internal pressure.*—In nine cases out of ten a continuous increasing pressure of steam without the means of escape is probably the immediate cause of explosion; in some instances it arises from deficiency of water, but accidents of this kind are comparatively few in number, as we often find in tracing the causes that they have their origin in undue pressure, emanating from progressive accumulation of steam of great force and intensity. Let us take an example—to some of which I am able to refer—and we shall find that a boiler under the influence of a furnace in active combustion (as the recipient of heat) will generate an immense quantity of steam, and unless this is carried off by the safety valve or the usual channels when generated, the greatest danger may be apprehended by the continuous increase of pressure that is taking place within the boiler. Suppose that from some cause the steam thus accumulated does not escape with the same rapidity with which it is generated, that the safety valves are either inadequate to the full discharge of the surplus steam, or that they are entirely inoperative, which is sometimes the case, and we have at once the clue to the injurious consequences which, as a matter of fact, are sure to follow. The event may be procrastinated, and repeated trials of the antagonist forces from within, and the resistance of the plates from without, may occur without any apparent danger, but these experiments often repeated will at length injure the resisting powers of the material, and the ultimatum will be the arrival of the fatal moment when the balance of the two forces are destroyed and explosion ensues. How very often do we find this to be the true cause of accidents arising from extreme internal pressure, and how very easily these accidents might be avoided by the attachment of proper safety valves, to allow the steam to escape and relieve the boiler of those severe trials which ultimately lead to destruction. If a boiler, whose generative power be equal to 100, be worked at a pressure of 10 lbs. on the square inch, the area of the safety valves should also be equal to 100, in order to prevent a continuous increase of pressure; or in case of the adhesion of any of the valves, it is desirable that their areas should, collectively, be equal to 100. If two or more valves are used, 100 or 120 would then be the measure of outlet. Under these precautions, and a boiler so constructed, the risk of accident is greatly diminished; and provided one of the valves is kept in working order, beyond the reach of interference by the engineer, *or any other person*, we may venture to assume that the means of escape are at hand, irrespective of the temporary stoppage of the usual channels for carrying off the steam. So many accidents have occurred from this cause—the defective state of the safety valves—that I must request attention whilst I enumerate a few of the most prominent cases that have come before me. In the year 1845 a tremendous explosion took place at a cotton mill in Bolton. The boilers, three in number, were situated under the

* From the London Artizan, for June, 1851.

mill, and from unequal capacity in the safety valves, and even those imperfect, as they were probably fast, a terrific explosion of the weakest boiler took place, which tore up the plates along the bottom, and the steam having no outlet at the top, not only burst out the end next the furnace, demolishing the building in that direction, but tearing up the top on the opposite side, the boiler was projected upwards in an oblique direction, carrying the floors, walls, and every other obstruction before it; ultimately it lodged itself across the railway at some distance from the building. Looking at the disastrous consequences of this accident, and the number of persons—from 16 to 18—who lost their lives on the occasion, it became a subject of deep interest to the community that a close investigation should immediately be instituted, and a recommendation followed that every precaution should be used in the construction as well as the management of boilers.

The next fatal occurrence on record in this district was a boiler at Ashton-under-Lyne, which exploded under similar circumstances, namely, from excessive interior pressure, when four or five lives were lost; and again at Hyde, where a similar accident occurrred from the same cause, which was afterwards traced to the insane act of the stoker or engineer, who prevented all means for the steam to escape by tying down the safety valve.

There was a boiler exploded at Malaga, in Spain, some years since, and my reason for noticing it in this place is to show that explosion may be apprehended from other causes than those enumerated in the divisions of this inquiry, and that is, *incrustation*. Dr. Ritterbrandt says—in a paper read before the institution of Civil Engineers, by an eminent chemist, Mr. West—"that a sudden evolution of steam under circumstances of incrustation is no uncommon occurrence:" in several instances I have known this to be the case, particularly in marine boilers, where the incrustation from salt water becomes a serious grievance, either as regards the duration of the boiler, or the economy of fuel.

If it were supposed, as Dr. Ritterbrandt observes, that the boiler was incrusted to the extent of half an inch, it would at once be seen that nothing was more easy than to heat the boiler strongly, even to red heat, without the immediate contact of water. Under these circumstances, the hardened deposits being firmly attached to the plates, and forming an imperfect conductor of heat, would greatly increase the temperature of the iron, and the great difference of temperature thus induced between the material—and the greater expansibility of the iron—would cause the incrustation to separate from the plates, and the water rushing in between them would generate a considerable charge of highly elastic steam, and thus endanger the security of the boiler.

These phenomena were singularly exemplified in the Malaga explosion, which is thus described by Mr. Hick:—"I have ascertained that a very thick incrustation of salt was found on the lower part of the boiler, immediately over the fire, and so far as it extended the plates appear to have been red hot, thereby much weakened, and hence the explosion. The ordinary working pressure of the boiler is 130 lbs. per square inch, and perhaps at the time of the explosion very much above that pressure, as there was only one small safety valve of two and a half inches diame-

ter. The boiler was only two feet six inches diameter, and twenty feet long."

Incrustation, exclusive of being dangerous, is attended with great expense and injury to the boiler by its removal. In the case of the Transatlantic, Oriental, or other long sea-going vessels—even after the use of brine pumps, blowing out, &c.,—a very large amount of incrustation is formed, and considerable sums of money are expended each voyage to remove it.

Other explosions of a more recent date are those which occurred at Bradford and Halifax. They are still fresh in the recollection of the public mind, and are so well known as not to require notice in this place.

I cannot, however, leave this part of the subject without reverting to an accident which occurred on the Lancashire and Yorkshire Railway, which had its origin in the same cause—excessive internal pressure. This accident is the more peculiar, as it led to a long mathematical disquisition as to the nature of the forces which produced results at once curious and interesting. The conclusions which I arrived at, although *practically right*, *were*, *however*, *considered by some mathematically wrong*, as they were firmly combated by several eminent mathematicians; and notwithstanding the number of algebraic formulas, and the learned discussions of my friends on that occasion, I have been unable to change the opinion I then formed of others more conclusive.

The accident here alluded to, occurred to the "Irk" locomotive engine, which in February, 1845, blew up and killed the driver, stoker, and another person who was standing near the spot at the time. A great difference of opinion as to the cause of this accident was prevalent in the minds of those who witnessed the explosion, some attributing it to a crack in the copper fire-box, and others to the weakness of the stays over the top —neither of these opinions were, however, correct, as it was afterwards demonstrated that the material was not only entirely free from cracks and flaws, but the stays were proved sufficient to resist a pressure of 150 to 200 lbs. on the square inch. The true cause was afterward ascertained to arise from the fastening down of the safety valve of the engine (an active fire being in operation under the boiler at the time) which was under the shed, with the steam up, ready to start with the early morning train.

The effect of this was the forcing down of the top of the copper fire box upon the blazing embers of the furnace, which, acting upon the principle of the rocket, elevated the boiler and engine of 20 tons weight to a height of 30 feet, which, in its ascent, made a summerset in the air, passed through the roof of the shed, and ultimately landed at a distance of 60 yards from its original position. The question which excited most interest, was the absolute force required to fracture the fire-box, its peculiar properties, when once liberated, and the elastic or continuous powers in operation, which forced the engine from its place to an elevation of 30 feet from the position on which it stood. An elaborate mathematical discussion ensued relative to the nature of these forces, wich ended in the opinion that a pressure sufficient to rupture the fire-box, was by its continuous action, sufficient to elevate the boiler and produce the results which followed. Another reason was assigned, namely, that an accu-

mulated force of elastic vapor, at a high temperature, with no outlet through the valves, having suddenly burst upon the glowing embers of the furnace, would charge the products of combustion with their equivalents of oxygen, and hence explosion followed. Whether one or both of these two causes were in operation is probably difficult to determine; at all events, we have in many instances precisely the same results produced from similar causes, and unless greater precaution is used in the prevention of excessive pressure, we may naturally expect a repetition of the same fatal results.

The preventives against accidents of this kind are well constructed boilers of the strongest form, and duly proportioned safety valves,—one under the immediate control of the engineer, and the other, as a reserve, under the keeping of some competent authority.

2d. Explosions from deficiency of water.

This division of the subject requires the utmost care and attention, as the circumstance of boilers being short of water is no unusual occurrence. Imminent danger frequently arises from this cause, and it cannot be too forcibly impressed upon the minds of engineers, that there is no part of the apparatus which constitutes the mountings of a boiler which requires greater attention—probably the safety valves not excepted—than that which supplies it with water. A well constructed pump, and self acting feeders—when boilers are worked at a low pressure—are indispensable, and where the latter cannot be applied, the glass tubular gauge steam and water cocks must have more than ordinary attention.

In a properly constructed boiler, every part of the metal exposed to the direct action of the fire should be in immediate contact with the water, and when proper provision is made to maintain the water at a uniform height and depth above the plates, accidents can never occur from this cause.

Should the water, however, get low from defects in the pump, or any stoppage of the regulating feed valves, and the plates over the furnace become red hot, we then risk the bursting of the boiler, even at the ordinary working pressure. We have no occasion, under such circumstances, to search for another cause, from the fact that the material when raised to a red heat has lost about five-sixths of its strength, and a force of less than one-sixth will be found amply sufficient to bear down the plates direct upon the fire, or to burst the boiler.

When a boiler becomes short of water, the first and perhaps the most natural action is to run to the feed valve, and pull it wide open. This certainly remedies the deficiency, but increases the danger, by suddenly pouring upon the incandescent plates a large body of water, which coming in contact with a reservoir of intense heat is calculated to produce highly elastic steam. This has been hitherto controverted by several eminent chemists and philosophers, but I make no doubt such is the case, unless the pressure has forced the plates into a concave shape, which for a time would retard the evaporization of the water when suddenly thrown upon them. Some curious experimental facts have been elicited on this subject, and those of M. Boutigney, and Professor Bowman, of King's College, London, show that a small quantity of water projected upon a hot plate does not touch it; that it forms itself into a globule surrounded

with a thin film, and rolls about upon the plate without the least appearance of evaporation. A repulsive action takes place, and these phenomena are explained upon the supposition that the spheroid has a perfectly reflecting surface, and consequently the heat of the incandescent plate is reflected back upon it. What is, however, the most extraordinary in these experiments is, the fact that the globule, whilst rolling upon a red hot plate, never exceeds a temperature of about 204 degrees of Fahrenheit; and in order to produce ebullition, it is necessary to cool the plate until the water begins to boil, when it is rapidly dissipated in steam.

The experiments by the committee of the Franklin Institute, on this subject, give some interesting and useful results. That committee found that the temperature of clean iron, at which it vaporized drops of water, was 334° Fahrenheit. The development of a repulsive force, which I have endeavored to describe, was however so rapid above that temperature, that drops which required but one second of time to disappear at the temperature of maximum vaporization, required 152 seconds when the metal was heated to 395° of Fahrenheit. The committee goes on to state that—"One ounce of water introduced into an iron bowl three-sixteenths of an inch thick, and supplied with heat by an oil-bath at the temperature of 346°, was vaporized in fifteen seconds, while at the initial temperature of 307°, that of the most rapid evaporization was thirteen seconds."

The cooling effect of the metal is here strikingly exemplified, by the increased rapidity of the evaporization, which at a reduced temperature of 38° is effected in thirteen instead of fifteen seconds.

This does not, however, hold good in every case, as an increased quantity of water, say from one-eighth of an ounce to two ounces, thrown upon heated plates, raised the temperature of its evaporation from 460° to 600° Fahrenheit: thus clearly showing that the time required for the generation of explosive steam under these circumstances is attended with danger, and it may be doubted whether the ordinary safety valves may not be wholly inadequate for its escape.

Numerous examples may be quoted to show that explosions from deficiency of water, although less frequent than those arising from undue pressure, are by no means uncommon—they are, nevertheless, comparatively fewer in number, and the preventives are good pumps, self-acting feeders (when they can be applied), and all those conveniences, such as water cocks, water gauges, floats, alarms, and other indicators of the loss and reduction of water in the boiler.

3*d*. *Explosions produced from collapse.*

Accidents from this cause can scarcely be called explosions, as they arise, not from internal force, which bursts the boiler, but from the sudden action of a vacuum within it. In high-pressure boilers, from their superior strength and circular form, these accidents seldom occur, and the low-pressure boiler is effectually guarded against it by a valve which opens inwards by the pressure of the atmosphere whenever a vacuum occurs. In some cases a collapse of the internal flues of boilers has been known to take place, from a partial vacuum within, which, united to the pressure of the steam, has forced down the top and sides of the flue, and with fatal effect discharged the contents of the boiler into the ash-

pit, and destroyed and scalded everything before it. A circumstance of this kind occurred on the Thames on board the steamer *Victoria*, some years since, when a number of persons lost their lives, and serious injury was sustained in all parts of the vessel within its reach. This accident could not, however, be called an explosion, but a collapse of the internal flues, which were of large dimensions, and the consequent discharge of large quantities of steam and water into the space occupied by the engines.

One or two cases which bear more directly on this point are, however, on record, and one of them, which took place in the Mold mines, in Flintshire, was attended with explosion. The particulars, as given by Mr. John Taylor, will be found circumstantially recorded in the first volume of the *Philosophical Magazine*. This occurrence seems to prove that rarefication produced in the flues of a high-pressure boiler may determine an explosion. The boiler which exploded belonged to a set of three feeding the same engine; the fuel used was bituminous coal. The furnace doors of all three of the boilers had been opened, and the dampers of two had been closed, when a gust of flame was seen to issue from the mouth of the furnace of these latter, and was immediately followed by an explosion. The interior flue of this boiler was flattened from the sides, the flue and shell of the boiler remaining in their places, and the safety valve upon the latter not being injured.

Other similar cases of collapse might be stated, but as most of them have been attended by a defective supply of water in the boiler, the plates over the fire having become heated, they can scarcely be included in the category of this class of accidents, and more properly belong to those of which we have just treated,—explosions from a deficiency of water in the boiler.

It is nevertheless necessary to observe that cases of collapse should be carefully guarded against, as the great source of danger is in the escape of hot water, which, with the steam generated by it, produces death in one of its worst and most painful forms.

The remedies for these accidents will be found in the vacuum valve, and careful construction in the form and strength of the flues.

4th. Explosions from defective construction.

This is, perhaps, one of the most important divisions that can possibly engage our attention, and on which it shall be my duty to enlarge. In a previous inquiry, I have already shown the nature of the strain and the ultimate resistance which the material used in the construction of boilers is able to bear. We have not, however, in all cases, shown the distribution and position in which that material should be placed in order to attain the maximum of strength, and afford to the public greater security in the resisting powers of vessels subject to so severe and sometimes ruinous pressure. This is a subject of such importance that I shall be under the necessity of trespassing upon your time, in endeavoring to point out the advantages peculiar to form, and the use of a sound and perfect system of construction.

For a number of years, the haycock, hemispherical, and wagon-shaped boilers were those generally in use, and it was not until high pressure steam was first introduced into Cornwall, that the cylindrical form with

hemispherical ends, and the furnace under the boiler, came into use; subsequently, this gave way to the introduction of a large internal flue extending the whole length of the boiler, and in this the furnace was placed. For many years this was the best and most economical boiler in Cornwall, and its introduction into this country has effected great improvements in the economy of fuel as well as the strength of the boiler. Several attempts have been made to improve this boiler by cutting away one half of the end, in order to admit a larger furnace. This was first done by the Butterley Company, and it has since gone by the name of the Butterley boiler. This construction has the same defects as the haycock or *hemispherical* and wagon-shaped boilers; it is weak over the fire place, and cannot well be strengthened without injury to the other parts of the boiler, from the vast number of stays necessary to suspend the part which forms the canopy of the furnace. Of late years a much greater improvement has, however, been effected by the double flue and double furnace boiler, which is now in general use, and has nearly superseded all the other constructions. It consists of the cylindrical form, varying from five to seven feet in diameter, with two flues, which extend the whole length of the boiler; they are perfectly cylindrical, and of sufficient magnitude to admit a furnace in each. This boiler is the simplest and probably the most effective that has yet been constructed. It presents a large flue surface as the recipient of heat, and the double flues when riveted to the flat ends add greatly to the security and strength of those parts. It moreover admits of the new process of alternate firing, so highly conducive to perfect combustion, and the prevention of the nuisance of smoke.

5th. Explosions arising from mismanagement or ignorance.

To mismanagement, ignorance, and the misapplication of a few leading principles in connexion with the use and application of steam, may be traced the great majority of accidents which from time to time occur. Many of these accidents, so fruitful of the destruction of property and human life, might be prevented, if we had well constructed vessels judiciously united to skill and competency in the management. To convey a few practical instructions to engineers, stokers, and engine men, would be an undertaking of no great difficulty. A young man of ordinary capacity would learn all that is necessary in a few months; and if placed under competent instructors, he might be made acquainted with the properties of steam, its elastic force at different degrees of pressure, the advantages peculiar to sensitive and easy-working safety-valves, the necessity for cleanliness and keeping them in good working condition; the use of water gauges, fusion plugs, indicators, signals, &c., &c., connected with the supply and height of water in the boiler. The dangers to be apprehended from a scarcity of water, the danger of explosion when the engine is standing, or when the usual channels for relieving the boiler of its surplus steam are stopped,—all these are parts of elementary instruction which the stoker, as well as the engineer, should be acquainted with, and no proprietor of a mill, captain of a steamship, or superintendant of locomotive, should give employment to any person unless they can produce certificates of good behaviour, and a knowledge of the elementary principles of their profession.

If these precautions were adopted, greater care observed in the selection of men of skill and responsibility in the construction of boilers, and a more strict and rigid code of laws in the management, we may look forward with greater certainty to a considerable diminution, if not a prevention, of those calamitous events which so frequently plunge whole families into mourning by unexpected and instantaneous death.

As an individual I would cheerfully lend my best assistance to the development of a principle of instruction, calculated to relieve the country of the ignorance which pervades that part of the community on which the lives of so many depend. A resolution on the part of those who employ persons of this description, and whose interests are so much at stake, to take none whose knowledge and character does not come up to the requisite standard, *and pay for it*, would soon find, from the economy of the management, and the increased security of their property, a very important change in all the requirements of the economy, as well as the application of steam. How often do we find implements of danger, and vessels containing the elements of destruction, in the hands of the most ignorant and reckless practitioners, whose insensibility to danger, and total incompetency to judge of its presence, renders them above all others the most unfit to be employed. And why? because they are the very persons, from their defective knowledge, to increase the danger and aggravate the evils they were selected to prevent. It is not the first time that engineers, to secure (if I may use the expression) an insane pressure, have fastened the safety valves, and screwed down the steam valve, closing every outlet, without ever thinking of the fire that was blazing under the boiler.

Under such circumstances what could be expected but a blow up? A madman rushing with a lighted match into a powder magazine could not act with greater insanity: such, however, has been the case, and that arising from want of thought, or what is worse, from the total absence of knowledge which it was the duty of his employer as well as himself to have possessed.

I have on former occasions, stated that I am not an advocate for legislative interference either in the construction or management of boilers, but seeing the dangerous tendency of these vessels when placed under the control of ignorance and incapacity, I would forego many considerations to encourage a more judicious and intelligent class of men than has hitherto been employed in the care and management of steam and the steam engine. The reforms necessary to be introduced may be done by the owners of steam engines, steam boats, railways, and others engaged in the use and application of this important element. A desire to enforce more judicious and stringent regulations, to remunerate talent, and to employ only those whose good conduct and superior knowledge entitled them to confidence, is the only sure guarantee of public safety and the prosperity of the employer.

Lastly. *The remedies applicable for the prevention of accidents arising from explosion.*

Having noticed in the foregoing remarks most of the causes incident to boiler explosions, it now only remains to draw such inferences as will point out the circumstances which it is desirable to cultivate, and others

which it is desirable to avoid. These circumstances I have endeavored to class in such way as to bring the subject prominently forward, and to point out under each head, first, the causes which lead to accident; and secondly, the means necessary to be observed in avoiding it. In a general summary it may not be inexpedient briefly to recapitulate these statements, in order to impress more forcibly upon the mind of those concerned the necessity for care and consideration in the use of one of the most powerful agents ever placed at our disposal.

One of the most scientific nations of Europe places the greatest confidence, as a means of safety , on the use of a fusible metal plate over the furnace. These plates are alloys of tin and lead with a small portion of bismuth, in such proportions as will ensure fusion at a temperature something below that of molten lead. In France, the greatest importance is attached to these alloys, and in order to ensure certainty as to the definite proportions, the plates are prepared at the royal mint, where they may be purchased duly prepared for use. In this country these alloys are not generally in use, but in this respect I think we are wrong, as boiler explosions are not so frequent in France as in this country, and high-pressure steam, from its superior economy, is more extensively used in France than in England. In my own practice I invariably insert a lead rivet one inch in diameter immediately over the fire place, and as lead melts at 640 degrees, I have invariably found these metallic plugs a great security in the event of a scarcity of water in the boiler. I am persuaded many dangerous explosions may be avoided by the use of this simple and effective precaution, and as pure lead melts at 600 degrees, we may infer from this circumstance that notice will be given and relief obtained before the internal pressure of the steam exceeds that of the resisting powers of the heated plates. As this simple precaution is so easily accomplished, I would advise its general adoption. It can do no harm to the boiler, and may be the means of averting explosions and the destruction of many valuable lives.

The fusible metal plates as used in France are generally covered by a perforated metallic disc, which protects the alloy of which the plate is composed, and allows it to ooze through as soon as the steam has attained the temperature necessary to insure the fusion of the plate. The nature of the alloy is, however, somewhat curious, as the different equivalents have different degrees of fluidity, and the portion which is the first to melt is forced out by the pressure of the steam, leaving the adhesion of the less fusible parts in a most imperfect state, incapable of resisting the internal force of the steam. The result of these compounds is, the fusion of one portion of the alloy and the fracture of the other, which is generally burst by pressure.

This latter description of fusible plates is different to the lead plug over the fire, as the one is fused at 600 degrees by the heat of the furnace, and the other, by the temperature of the steam, raised to the fusible point of the alloy, which varies from 280 to 350 degrees.

Another method is the bursting plate, fixed in a frame and attached to some convenient part of the upper side of the boiler; this plate to be of such thickness and of such ductility as to cause rupture whenever the pressure exceeds that of the weight on the safety-valve. There can be

no doubt that such an apparatus, if made with a sufficiently large opening, would relieve the boiler; but the objection to this and several other devices is the frequent bursting of those plates, and the effect every change of pressure has upon the material in reducing its powers of resistance, and thus increasing uncertainty as to the amount of pressure in the boiler, as well as the constant renewal of the plates.

It has already been noticed that one of the most important securities against explosions is a duly proportioned boiler, well constructed, and to this must be added ample means for the escape of the steam on every occasion when the usual channels have been suddenly stopped. The only legitimate outlets under these circumstances appear to me to be the safety valves, which, connected with this inquiry, are indispensable to security. Every boiler should, therefore, have two safety-valves, of sufficient capacity to carry off the quantity of steam generated by the boiler. One of these valves should be of the common construction, and the other beyond the reach of the engineer or any other person.

Defective construction is unquestionably one of the greatest sources of the frightful accidents which we are so frequently called upon to witness. No man should be allowed unlimited exercise of judgment in a question of such vital importance as the construction of a boiler, unless duly qualified by matured experience in the theoretical and practical knowledge of form, strength of materials, and other requirements requisite to insure the maximum of sound construction. It appears to me equally important that we should have the same proofs and acknowledged system of operations in the construction of boilers, as we have in the strength and proportions of ordnance. In both cases we have to deal with a powerful and dangerous element, and I have yet to learn why the same security should not be given to the general public as we find so liberally extended to an important branch of the public service. In the ordnance department at Woolwich (with which I have been more or less connected for many years) the utmost care and precision is observed in the manufacture of guns, and the proofs are so carefully made under the superintendance of competent officers as to render every gun an engine of perfect safety to the extent of 1000 to 1200 rounds of shot.

For the Journal of the Franklin Institute.

Arrival of the Screw Steamer "City of Manchester."

This fine screw steamer has recently arrived at our city, after a passage of 18 days from Liverpool to the Capes, having a full freight list and a large number of passengers, thus proving that freight and passengers may be obtained in sufficient quantities for this Port, when suitable vessels are provided for the trade. This vessel is the second of the line, the City of Glasgow being the first; the third vessel, the City of Pittsburg, is nearly completed in New York, and will be put on the line this fall. The fourth vessel is yet to be built, and it is to be hoped that an enterprise that has obtained a large amount of its support from this city, may be able to diffuse a portion of its money among our mechanics, who are, at least, entitled to the courtesy of a trial when they are willing

to *guarantee* as good a result as has been obtained by any screw steamer of the same class. The City of Manchester is of iron, 274 feet long on deck, 37 feet 9 inches beam, 31 feet hold, burthen 1900 tons Custom House measurement, being the largest iron steamer yet built, (the Great Britain excepted.) She has four masts, two of them only with yards, but the other two carry very large gaff topsails, so that, when necessary, she can spread a very large amount of canvass. The propelling power consists of two vertical beam engines placed across the ship. Diameter of cylinders 73 inches, and stroke 5 feet. The beams consist each of two plates of wrought iron, supported on cast iron columns, which rise from, and are securely attached to, the bed plate of the engine. On the crank shaft of the two engines (which are connected together at right angles) is a large spur wheel 9½ feet diameter, and 4½ feet face, having wooden teeth, which gear into a pinion of 4¾ feet diameter on the propeller shaft, so that each revolution of the engines, produces 2 revolutions of the propeller, which is 14 feet diameter, and 19 feet pi ch; on her trial trip to Belfast, her engines made an average of 25 revolutions, and her reported speed was 11 knots per hour. As a fine specimen of iron ship building, she is well worthy of the examination of our mechanics, the more so as this is the iron emporium of the United States, and sooner or later, iron steamers will have to be built. Even at the present moment, they are the cheapest when every thing is taken into consideration, but it would be hard to convince our merchants of the fact, unless they would take the matter fully in hand, and examine it in all its bearings. To such as are disposed to look fairly at the subject, I risk nothing in stating that I could soon convince them that *iron* was (all things considered) the cheapest material for ship building. B.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 128.

The device of the local circuit in the Morse Telegraph was founded in part upon the experiments of Prof. Henry, who had previous to this, "opened the circuit of a large quantity magnet at Princeton, when loaded with several hundred pounds, by attracting upwards a small piece of movable wire, by means of a small intensity magnet, connected with a long wire circuit and an intensity battery."

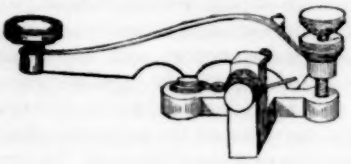
The re-issued patent of January 15th, 1846, and the patent of 11th of April, 1846, were both re-issued on the 13th of June 1848, and another patent containing improvements in the electric Telegraph was taken out on the 1st of May, 1849.

The line between Baltimore and Washington, is the only one constructed under governmental patronage, the remainder having been projected by private enterprise; the patentee being allowed one half the stock for the use of the patent, as his share of the investment; the capital invested in them up to January 1st, 1850, was nearly $400,000, exclusive

of the patent right, upon which Prof. Morse up to that time had received some $30,000. The machine at present in use, consists of three main portions, the transmitting and receiving apparatuses with the connecting circuit.

The spring lever key as at present used in the Morse Office, was suggested by Mr. Thomas C. Avery, of New York, but has received various modifications; in Fig. 24, we have a view of its present improved form:

Fig. 24.

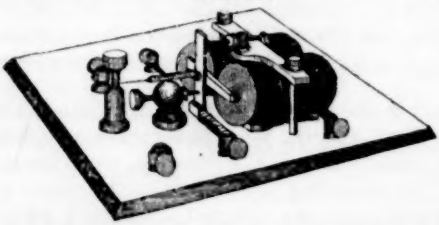


it consists of a nicely balanced lever, supported on standards raised from a small block of mahogany; thumb screws are fixed to each extremity of it, that on the longer arm being used for the operator to play upon, and the shorter one to adjust the distance of the connecting surfaces; on the short arm is attached a spring to keep those surfaces apart when not pressed together by the operator; the connecting surfaces called the hammer and the anvil, the former on the lower surface of the long arm of the lever, the latter on the mahogany support, are faced with platinum; they are respectively connected with the opposite poles of the galvanic circuit, and by their contact or separation, the circuit is united or broken.

If this key is at an intermediate station, by means of the screw on the short arm the surfaces are kept together; the circuit may be closed when not in use; this permits communications to be sent through the office between stations on each side of it, or rather it keeps the main circuit continuous; when operating, if they are merely touched, a point is made at the receiving station, if kept together any time a line is produced whose length is governed by the period of contact; the circuit connexions are beneath, one below the anvil, the other under the screw.

The receiving magnet is an intensity one, surrounded by a helix of

Fig. 25.

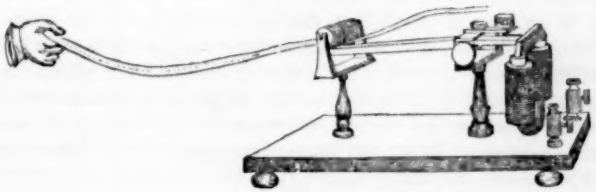


very fine wire, 3000 feet or more in length, having the horse shoe form, and fixed in a horizontal position. The main circuit passes through this helix unbroken to the next station; an armature is fixed to a vertical movable standard, opposite the poles of this magnet, in such a manner, that by means of a spring and adjusting screws, it cannot come in actual contact with the magnet, nor yet is it so far removed as to be beyond its influence; the object of this delicate suspension, is that the armature may be approached to or withdrawn from the magnet's influence according to the intensity of the current; much of the operator's skill depends on the management of this adjuster, as the varying electrical agencies of the atmosphere and generating forces of the batteries are constantly operating to increase or diminish its intensity.

The support of this armature forms part of the local circuit, the hori-

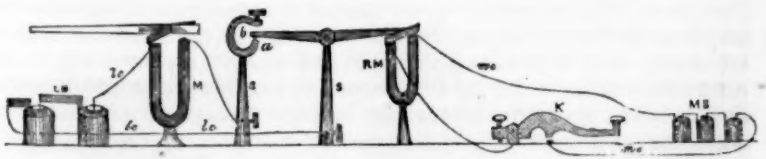
zontal rod above another part, and the circuit is closed, by the attraction of this armature to the poles of the magnet, through the horizontal rod above, terminating in a platinum face, opposite another one fixed on the horizontal support above the magnet; the connexions of the local circuit are through screws seen on the right; when the current flows through the main circuit the receiving magnet attracts the armature, and thus closes the local circuit, the only place where it is open being above the horizontal bar over the helix: the local circuit is confined entirely to the office where it belongs, passing through the local battery and the helix of the register magnet, being distinct from the main; the registering apparatus has or should have, a quantity magnet of a horse shoe form, fixed vertically, the open extremity upward; the object being to indent impressions upon paper; force, rather than delicacy, is requisite. The figure from Davis' Manual of Magnetism, represents the mechanical

Fig. 26.



action of the instrument; above the poles of the magnet, is an armature attached to one end of a movable lever, which has on the upper surface of the other end, a metal point which fits into a groove of a roller above it; the passage of the galvanic current making the magnet attract and depress the armature, raises the points at the other extremity, and makes an impression on the paper in dots or lines, according to the duration of the current; a spring is used here to withdraw the armature from the magnet after the cessation of the current, which must be so arranged, as not to carry the armature too far from the magnet, or let the points too deep into the groove; a lead pencil was first used, afterwards a pen with an ink reservoir, which was laid aside for the hard steel points; the impressions on the paper resemble the raised printing for the blind; the connexion with the local battery is made through the screw caps on the right hand.

Fig. 27.



"Fig. 27 represents the arrangement and relations of the magnets, batteries, and circuits: R M representing the small magnet, *m c* the main circuit of indefinite extent, M B the distant battery, K the key which breaks and closes this extended circuit; *l c* and L B represent the local

circuit and battery, M the helices of the register magnet included in the circuit, which, as the standards, S S, are metallic, is broken only at the points *a b*. Now, the least possible space between these points effectually interrupts the current, and as they are covered with platinum, a very slight contact is sufficient to establish the connexion. The little instrument is so delicately adjustable, that often, when the breath would stop the vibrations of the lever, the circuit is broken and closed with certainty and regularity; this is also shown on a larger scale in fig. 28."

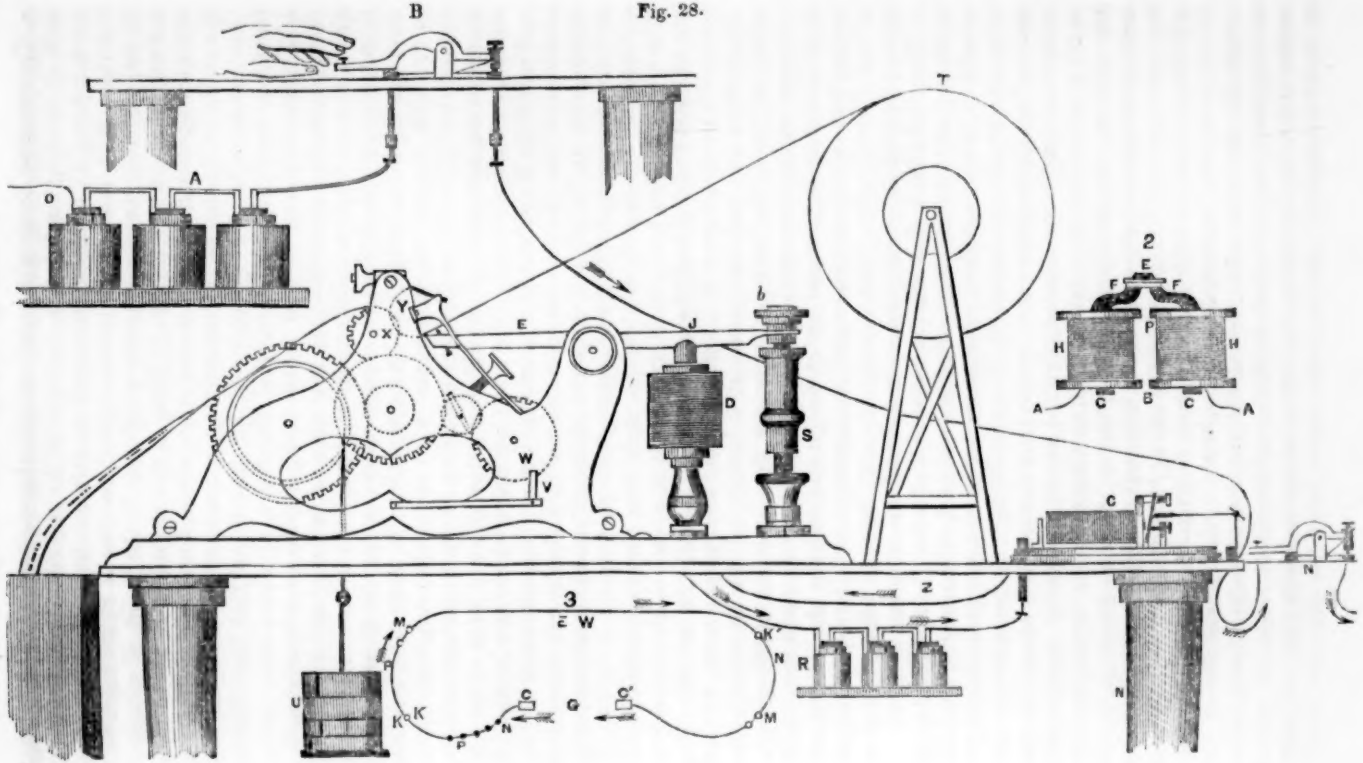
Many forms of this instrument have been devised, some with the levers vertical; in others, the magnet was attached at one end, and the style at the other end of a shaft working through a horizontal tube.

The figure (28) slightly amended, from one in the *Phrenological Journal*, March, 1851, represents the whole combination of the registering apparatus and its connexions with the main and local circuits, together with the distant and local operating keys. The register occupies the centre of the picture, being supported on two standards: T is a spool carrying a roll of paper; this paper is prepared by manufacturers for this especial use, by winding it into large rolls, and dividing it into smaller rolls of one inch or more in width by a knife, while it is revolving in a lathe; from this spool the paper is drawn between the two rollers *x* and *y*, which are turned by means of the weight U, moving the clock work above it; D is the register magnet, E the lever, having the armature at L, and its axis or fulcrum to the left of it, also at the extreme left, the style playing in a groove of the lower surface of the wheel *y*: S on the right, is a screw to limit the motion of the style, a distance of one-eighth of an inch being usually allowed; it also contains a spiral spring below, to separate the armature and magnet; the paper is dealt off steadily from the spool, and a momentum is prevented by springs fixed on the axis of the spool between the latter and its standards; formerly a break was suspended from the lower surface of the lever upon some of the clock wheels below, to permit and arrest their motion, but this is now supplied by the small jack V setting into the cogs of the wheel W, the swiftest one in the train; this the operator pushes down immediately on the reception of a signal and the weight U sets the whole in motion, drawing the paper off the spool between the rollers *x* and *y*, the style impressing on it the required characters, and it rolls finally into the vessel on the left, ready to be read at the convenience of the receiver.

In the earlier forms an alarm was appended to call the attendant's attention, but this is thrown aside, as the click of the register answers the purpose; some experienced operators become so accustomed to this click that they can declare the message without referring to the character made by the style; thus it becomes phonetic, and operators conversing at vast distances, can make the little instrument by its varied action, slow, rapid, or impetuous, give expression to the different feelings of the mind; each office has its own peculiar signal, known to all the rest on the line, and an answer is expected as soon as it is given.

The machine is wound up by a key fixed to the axis of the largest wheel on the left; some guides are used to conduct the paper beneath the style with such regularity that several communications may be printed parallel to each other on the same strip.

Fig. 28.



The peculiar form of magnet used in the registering department, is seen in the diagram No. 2, to the right of the register. A, A, the circuit connexions; C C, lower extremities of the soft iron bars, which are joined together; H H, reels of the helices around the iron; F F, the upper ends of the soft iron, having opposite polarities; P, the point of connexion between the wires of the two helices; E, the armature; B, above represents the operating key of a distant office, situated on the main line, with the attendant in the act of transmitting a communication; O, the main line coming from the distance; A, the battery on that line; Groves' battery is mostly in use, 30 cups of which are necessary in a space of 150 miles; they may be kept in one body, but it is better to distribute them at intervals along the line; they require cleansing and replenishing about once a fortnight. After passing through the key, the main circuit follows the course of the arrow to the receiving magnet C on the right, traverses the helix of that, and issues again from it, continuing its course to the right, to the next station, and so it might go on indefinitely, or around the world; N, is the local operating key through which the line passes in the same manner as at B; this is the entire relation of the main circuit to an office; it makes the receiving magnet close the local circuit, and it will do it not only at one station, but at all on the same line, and at the same time; so that an operator in Philadelphia, can transmit his message to St. Louis, and drop it at all the intermediate stations at one and the same moment; this has actually been performed.

Only one wire is now used on the main line, the earth affording the return circuit; No. 3, shows it very well; one end of the line may be supposed at Philadelphia, the other at New York; M M, receiving magnets of the two stations; K K, the operating keys respectively, P and N, the positive and negative poles of a battery on the line: C C, plates where the wires terminate in the ground: the connexion of the wires to a gas pipe, will answer every purpose; the arrows represent the direction of the current; G, that portion of the ground forming the circuit. By having two wires, one connected respectively to the keys and magnets of the different offices, communications may be sent both ways at the same time, but only one current can traverse the same line at once.

The local circuit Z is short, simple, and effective, being closed by the receiving magnet; C the current starts from the local battery R, consisting usually of from two to three cups, that must be cleansed every morning for efficient operation, runs through the helix D, back to the receiving magnet in the course of the arrow to the local battery; this causes the style to raise and make an impression on the paper; the whole operation then is very simple; the key depressed at a distant city or station, B causes the receiving magnet C, at Philadelphia, to close the local circuit: the iron of the helix D is made instantly magnetic, and the style goes against the paper, and stays there as long as the key is kept down at B. A simple contact makes a dot (·), a longer time a line (—). Considerable experience is requisite to make a good operator, either to transmit or read messages; some, however, become quite proficient after three months tuition; the interval between the times of contact, is regarded as well as the letter, for by its length, letters, words and sentences, are distin-

guished from each other; the adjoined table contains the Morse Telegraphic characters.

A ·—	J ·———	S ···	Numerals.	9 ————·	
B —···	K —·—	T —	1 ·————	0 —————	
C —·—·	L ·—··	U ··—	2 ··———		
D —··	M ——	V ···—	3 ···——		
E ·	N —·	W ·——	4 ····—		
F ··—·	O ———	X —··—	5 ·····		
G ——·	P ·——··	Y —·——	6 —····		
H ····	Q ——·—	Z ——··	7 ——···		
I ··	R ·—·	& ·——··	8 ———··		

If an operator at Philadelphia, wishes to send a communication to Baltimore, he first breaks the main circuit by opening the operating key at his station. All the receiving magnets in that circuit cease to attract their armatures, the spring draws them away from the magnets, and thus breaks all the short office circuits. The Philadelphia operator then makes the signal for Baltimore, by tapping on his key, the proper number of times; this produces a clicking of the registers, which is heard and understood in all the offices on the line, though none but the Baltimore operator pays any regard to it.

Then the Baltimore operator opens his transmitting or operating key, and breaks the main circuit in another place, so that the Philadelphia operator cannot operate his main circuit, which the latter discovers by the silence of his own receiving magnet when he operates his key; he then closes his key to permit the operator at Baltimore to return an answer.

The Baltimore operator closes his key, sets his clock work in motion, and returns word that his Philadelphia correspondent may send his communication, which the latter hears, and goes to work accordingly.

If the Philadelphia operator wishes to telegraph his message to several or all the stations on the line, he makes in succession, all the signals of those offices, and awaits their replies; after receiving them all, he commences to operate, and the communication is received by every one of them at the same moment.

The daily performance of this machine is to transmit from 8000 to 9000 letters per hour; there are a number of attendants needed about an office transacting much business, each one of whom has his respective department: they are divided into "copyists, book keepers, battery keepers, messengers, line inspectors and repairers"; the usual charge of transmission is 25 cts. for ten words sent one hundred miles; the messages vary in value from 10 cts. to $100; the amount of business which a well conducted office can perform, and the nett proceeds arising therefrom, may well excite our surprise; a single office in this country with two wires, one 500, the other 200 miles in length, after spending three hours in the transmission of public news, telegraphed in a single day, 450 private messages averaging 25 words each, besides the address, sixty of which were sent in rotation, without a word of repetition.

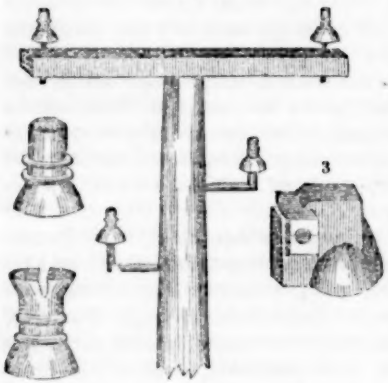
The public journals, however, often contain notices of errors committed by the operators on these lines, which, from their importance, have been the cause of considerable complaint among business and newsmen. This is variously attributed to careless attendants, disarrangement of the

circuits, or the alphabetic combination, which renders the best receivers and copyists liable to mistake; this is not all, for instances can be cited where messages sent immediately, as the clerks promised to do, would have answered the desired end, but being delayed three hours, were utterly valueless.

Several important things are necessary to the successful operation of the instrument; skilful manipulators, good batteries and machines, and more than all, thorough insulation of the conductors; the latter can never be completely accomplished, as the best non-conductors will conduct in a slight degree. Copper wire first employed, has, on account of expense, been laid aside for iron, of which 300 lbs. are required to a mile: the method of insulation consists in winding them around glass knobs, passing them through caps of the same material, or enclosing them throughout with gutta percha.

"The figure shows the methods of attaching them to glass caps, by supporting the wire from their side (1,) or resting them in a groove on the top (2,) these caps fit over wooden or iron pins, which are fastened on the top of horizontal cross bars, or driven into the side of the post; two blocks of glass in the form of a parallelopiped, and dovetailed together in such a manner, as to let a wire, without any other fastening, slide through a central opening; the glass being surrounded and protected by wood; the most recent method consists of glass blocks, fitted in cast iron caps and supported on the peg by a heavy glass tube (3.) The caps, of whatever form, are either upon cross-bars, or supported by iron staples driven into the post."

Fig. 28.



Notwithstanding these precautions, by the contact of wires blown about by winds, moisture, &c., connexions are made through the ground or otherwise, and a short circuit is formed, instead of going the entire route of the line, or part of the current of greatly diminished intensity, pursues the latter course.

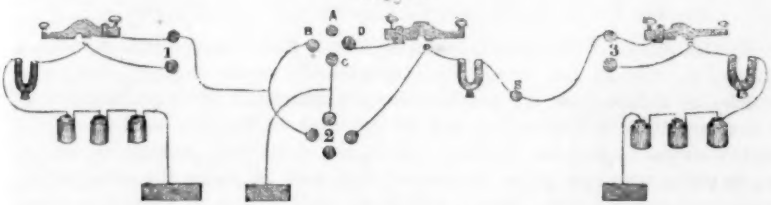
The following method of ascertaining the existence of a break, or forming connexions with different offices at will, is well described by Mr. Chas. T. Chester of New York, in Silliman's Journal, Vol. v. 2d, series. It has been found that the intermediate offices on a main line are of great utility in determining the situation of the breech.

If the circuit is broken on one side, a current is at once obtained from the battery of the unbroken side, and the accident found is repaired. The diagram shows how to apply this test, and the method of dividing the long line into sections. The black dots, A B C D, in Fig. 31, represent brass terminations of conductors, sunk on a level with the surface of the

operator's table; a metallic button, fig. 30, plays over their surface. This button connects each brass stud with its opposite, and a change in its position changes the direction and channel of the current at pleasure. Thus, the intermediate operator wishes to break and close the "through circuit, (this is synonymous with main circuit,) he turns his button, bringing B in contact with D; the course of the current can be easily traced. But again, cutting off his left hand neighbor, he wishes to converse with his right, the button changed so as to connect A with C, the current passes directly to the ground through his instruments. Supposing a binding screw at S, the left or right hand wire may thus be brought in connexion with the ground. The buttons 1, 2, and 3, are simply used as convenient duplicate keys, or circuit closers, when the operator is receiving."

Fig. 30.

Fig. 31.



When the line is found deranged at an intermediate office, by the evidence of a current unnaturally strong or weak, the impression is that the wire is broken at one or both sides of the office. Supposing the wire continuous from one end of the line to the other, and a battery at each, the current passes through the intermediate magnet without interruption, and the circuit established is termed a "through circuit." When a derangement is perceived, the intermediate operator alters the through circuit, and by connecting with the ground, makes two short circuits.

Several methods have been devised to obviate the disastrous consequences that sometimes result from violent electrical action during thunder storms, such as the melting or breaking of wires, total destruction of long distances of the circuit, injury to office furniture or the operators connected with it; among the most important of which are those that combine the readiest communication with the ground to convey away the superabundant fluid; one is to have the circuit closer of a receiving magnet, employed for this sole purpose, pass into the earth; another is the metallic connexion with the surface of a brass ball, surrounded by a ring situated in and forming part of the circuit, from the inner circumference of which minute metallic points project towards, but do not quite touch the ball; both of these, however, are inefficient at times.

Professor Morse, has deservedly received the highest approbations of the American people for the invention that not only calls forth wonder at its accomplishments, but has proved itself an invaluable agent in political economy. Excepting efficient and economical batteries, most of the discoveries in this department of science had been made, which were essential to a proper foundation of his invention; some hand was necessary to elicit the remaining facts, combine and give them a mechanical

arrangement and application, and then to thrust it before a distrustful public, to solicit the attention and patronage of the government for the proper attestation of its merits.

It was novel to the American people; no one had projected the thing here successfully, though many had thought of, and some tried it; through Professor Morse's indefatigable perseverance, the adjuvant resources of science were united in the form of utility; though dependant for most of his information upon others, he had the confidence in its final success, to master opposing obstacles, and bring to his aid, those who had labored honorably and prosperously in the progress of knowledge.

To be Continued.

For the Journal of the Franklin Institute.

On P. V. Du Trembley's Combined Vapor Engine.

At the works of Messrs Stillman & Allen, New York, there is now in operation, one of Du Trembley's combined vapor engines, which is worthy of notice from its peculiar construction; but more particularly as it is claimed by the inventor, that 50 per cent. of the fuel used in the ordinary steam engine and boiler, will in the combined engine be saved; or, in other words, a given amount of fuel will do twice the work in the combined vapor engine, that it will in the ordinary steam engine, a result most devoutly to be wished, no matter how cheap fuel may become. A description of the engine is here given in the inventor's own language:—

"This invention is applied either to a single engine, with two cylinders and pistons, or, as is usual for maritime purposes, two distinct engines, with a cylinder and piston each. In either case, one of the pistons is acted upon by steam, and the other by the vapor of perchloride, or of any other easily vaporized liquid, termed auxiliary liquid. The steam power is generated and applied as in the ordinary engine; but upon the escape of the steam from the first cylinder, after having exerted its expansive force therein, it passes into an air-tight case, termed a vaporizer, containing a number of small tubes charged with perchloride, or some easily vaporized liquid, penetrates into the space between, and comes in contact with the entire surface of the tubes. The faculty of absorbing caloric, possessed by liquids of the before mentioned class, is so powerful, that immediately upon the steam coming in contact with the surface of the tubes charged therewith, a large portion of the caloric of the steam is absorbed by the liquid in the tubes, which becomes thereby vaporized, and the steam being thus deprived of its caloric, is immediately condensed and is then returned into the steam boiler. The vapor thus obtained by the action of the steam, or perchloride, or other liquid in the tubes, termed auxiliary vapor, is conducted into the second cylinder, and after exerting its elastic force (which is greater than steam) upon the piston in the second cylinder, is condensed, and by means of a force pump is returned into the vaporizer, which it thus keeps regularly supplied, and is alternately vaporized and condensed. The saving effected by this engine is in the small quantity of coals required for the steam, the smaller room occupied by it, and the avoidance of incrustation in the boiler, the water being completely distilled by the reiteration, vaporization, and condensation. The perchloride is a very cheap fluid; when once charged, the quantity in the tubes will last a considerable time, the alternate condensation and vaporization occasioning a very trifling loss in the bulk or quantity employed. Every liquid boiling at a low temperature can be used. The best, according to the trials, are sulphuric ether, sulphur of carbon, chloroform, chloride of carbon; the first two are inflammable, the last two are not."

Without discussing the *practical* merits of the invention, I should like to enquire if the same economic result could not be produced by using the easily vaporized liquid directly in the boiler itself. Second, what evil result (if any) would be produced by the oil, which has occasionally

to be used in every working cylinder. In long voyages, this oil in the aggregate, amounts to a large quantity, and some means are absolutely necessary to get rid of it. Will not the mixture of oil with the easily vaporized liquid change in some way its nature? I hope that Mr. Du Trembley has accomplished all he states, and that his engine will prove something more than a model. FULTON.

For the Journal of the Franklin Institute.

Passage of the Steamer Baltic from Liverpool.

The Quickest Trip on Record, has been made by the steamer Baltic of the Collins line of steamers. She left Liverpool at 4 o'clock P. M., on Wednesday the 6th of August, and passed the battery at New York, at 20 minutes past 6, on Saturday morning the 16th. Apparent time 9 days, 14 hours, 20 minutes. Actual time 9 days, 18 hours, 45 minutes. She had good weather and fair winds for the greater part of the passage, and her daily run was as follows:—

Wednesday,	Aug.	6, left Liverpool, 4 p. m.		
Thursday,	"	7 . .	12	m 245 miles.
Friday,	"	8 . . .	12	" 310
Saturday,	"	9 . .	12	" 315
Sunday,	"	10 . . .	12	" 326
Monday,	"	11 . .	12	" 315
Tuesday,	"	12 . . .	12	" 325
Wednesday,	"	13 . .	12	" 324
Thursday,	"	14 . . .	12	" 312
Friday,	"	15 . .	12	" 330
Saturday,	"	16 ar. at N. Y. 6-20 a. m.		237

On the arrival of the Baltic, the engineers of the Pacific presented to the engineers of the Baltic, the wreath of championship which they had received at the time they made their quick trip, it being well understood that the one who makes the quickest trip, is to have the custody of the said wreath, and is of course, by right, the champion of the line, to say nothing of the Cunard steamers, which are now allowed to arrive and depart without note, so far as speed is concerned. H.

For the Journal of the Franklin Institute.

Lake Steamer Buckeye State.

This vessel, recently added to our lake fleet, has some peculiar features in her machinery, which render her worthy of special note. She has one of Smith & Baird's compound expansion annular beam engines, being the first of the kind applied to any steamer in this or any country; the whole has been arranged by Erastus W. Smith, Esq., engineer, of New York City, and is a good specimen of engineering. The peculiar feature of this engine, is the employment of two cylinders, one being situated within the other, both having the same stroke of piston. The small cylinder has a diameter of 37 inches, and a stroke of 11 feet, and into it the steam from the boiler of 40 lbs. average pressure is admitted, by a set of double balance valves, of the usual form. The larger cylinder surrounds the inner one, its diameter is 80 inches. The space between the two

forms an annular chamber, and the large piston has two rods, and is packed on its inner and outer circumference; with this exception, the engine is of the usual form; but the advantage of admitting steam of high pressure, full stroke, or nearly so, on to the piston of the small cylinder, and expanding it into the large cylinder, must be apparent, as the great shock caused by the admission of steam of high pressure on to the area of a large piston, is almost entirely got rid of, and the method of expansion is more efficient. The following are some of the dimensions of the Buckeye State:—

	Feet.	Inches.
Length on Deck,	282	0
Breadth of Beam,	32	11
Depth of Hold,	13	0
Tonnage, tons,	1187	
Diameter of Water Wheel,	35	0
Length of Paddles,	9	8
Depth " "	2	2
Dip of Wheel,	3	10
Average number of Revolutions,	16	
" Pressure of steam, lbs.	40	
" Consumption of Bituminous Coal per hour, "	3158	

While the Mayflower, a boat of about the same size and speed, consumes 6160 lbs per hour, showing a decided saving of fuel. She has three boilers with square fronts, 9 feet wide, and round shells 9 feet diameter, and in length 17 feet 9 inches. Each boiler has but one furnace, 8 feet wide, with grates 6 feet 6 inches long, with two lower flues of 20 inches diameter, and one of 26 inches; the return to the chimney, which is in front, is through 190 tubes of 3 inches internal diameter, which tubes rise 4 inches at the front end; whole number of tubes 570; diameter of chimney 6½ feet; height above grate, 65 feet; draft natural, and steam abundant; no trouble has yet been experienced from the great length of tube. It would be desirable to know the temperature in the chimney, as it is possible that the tubes may be longer than is necessary, as it has generally been supposed that very long tubes gave no additional evaporating power. This question is an important one, and I shall have it examined into, and will report at some future time. X.

Recent Improvements in Photography. By Robert Hunt.*

With the advance of this beautiful art there appears to be a progressively increasing desire to produce more artistic results; and numerous manipulatory improvements have recently been introduced, many of them with the most decided advantage. It is thought desirable, therefore, to devote a short space to the description and consideration of such of these as are the most important.

The use of collodion promises to be of exceeding importance. Collodion is a peculiar preparation, formed by dissolving gun-cotton in ether; it is a very mucilaginous solution, of a volatile character, and the ether evaporating, leaves a film of the utmost transparency behind. It is not all kinds of gun-cotton which dissolve equally well in ether; the most easily soluble is prepared by soaking good cotton in a saturated solution of nitrate of potash for some time: it is then, in a moist state, plunged into

* From the London Art Journal for July, 1851.

sulphuric acid, with which but a small quantity of nitric acid has been mixed. After remaining in the acid for about a minute, it is well washed with water, until no trace of an acid taste is discovered, and then dried at a temperature but very slightly elevated above that of the apartment.

Having obtained the collodion, the mode of proceeding best adapted for insuring success appears to be the following:

Iodide of silver is precipitated from a solution of the nitrate of silver by adding iodide of potassium to it, the yellow precipitate being well washed so as to remove every trace of nitrate of potash; it is then dissolved in a saturated solution of the iodide of potassium. This mixture is added in small quantities to the collodion, and the whole well agitated; by this means we obtain a combination of this peculiar substance with iodide of silver and potassium. Mr. Archer, who has devoted considerable attention to this preparation, prepares what he calls a collodoiodide of silver, whether in the above manner we are not certain. Mr. Archer's preparation is exceedingly sensitive, but the above is believed to be equally so. To use it, no other manipulation is necessary than to pour the mixture over a glass plate held upon the hand, moving the glass to and fro, to ensure the complete coating of every part; the fluid is poured off by one of the corners, and the film which adheres to the glass dries almost immediately. This is then washed over with the gallo-nitrate of silver, in the same manner as on the albuminised glass plates, and it is ready for the camera. Where the proportions have been happily hit upon, the result is the production of a picture almost instantaneously. Very fine portraits are obtainable in about ten seconds in diffused light; the image is developed in the same manner as in the calotype process, by the use of the gallo-nitrate of silver, and fixed by means of the hyposulphite of soda.

By the kindness of Mr. Horne we are enabled to add the following mode of operating. Mr. Horne has been so successful an operator with the collodion that we print his communication entire, that no part of his instructions may be lost:—

"The first article is the collodion, and most persons are aware that this is a solution of gun-cotton in ether, but, for the purpose now under consideration, should contain a small quantity of iodide of silver dissolved in excess of iodide of potassium. It should be sufficiently limpid to run freely over a plate when poured on, or ether must be added until this result is obtained. If the collodion is too thick, great difficulty will be experienced in obtaining an even coating; but when of a proper consistence, plates of any size may be readily coated.

"The plan which I have adopted, and with great success, is as follows:—Take a piece of flat glass cut to the size of frame, and, having washed it with water, and wiped the same quite dry, then, either by holding at one corner, or if large, placing it on a levelling-stand, pour on the centre of the plate a good body of liquid which will readily diffuse itself equally over the surface. Immediately pour the liquid off again into the bottle from one corner; and by bringing the hand holding the plate down a little, that the liquid may run to the lower edge, and drawing the mouth of the bottle along, those lines first formed will run

one into the other, and give a flat even surface. Very little practice will soon enable any operator to obtain this result. The plate is now *immediately*, and before the whole of the ether has had time to evaporate, to be immersed in a bath of nitrate of silver, 30 grains to the ounce, *until the greasy appearance which it first presents on immersion is entirely gone, and the silver solution flows freely over the surface.*

"The plate should now, and in its moist state, be placed in the camera and the picture taken; the time of exposure varying, of course, with the light, but for a portrait, and with a moderately quick lens, from three to thirty seconds will be sufficient. Mr. Fry, who was the first to practise with collodion, has obtained beautiful portraits by placing the sitter in the open air, and simply removing the cap from the lens, and closing it again as soon as possible.

"The agent for developing these pictures is unquestionably the pyro-gallic acid, as recommended by Mr. Archer; and I am told the proto-nitrate of iron also answers equally well. The solution of pyro-gallic acid should be made as follows:—

Pyro-gallic acid, ...	3 grains.
Glacial acetic acid, ...	1 drachm.
Distilled water, ...	1 ounce.

The plate having been placed, face upwards, upon a levelling-stand, a sufficient quantity of the above solution should be poured equally and quickly over the surface, and the picture allowed to develop, occasionally slightly moving the plate, to prevent the deposit which will take place settling at one spot. A few drops of a solution of nitrate of silver, five grains to the ounce, may also, in dull weather, be added to the pyro-gallic, with advantage, just before pouring it over the plate; but in very bright weather the picture will develop sufficiently quick with the pyro-gallic acid solution alone.

"The development may be readily judged of by holding a piece of white paper occasionally under the plate; and as soon as sufficient intensity has been obtained, the solution must be poured off, and the plate washed by a gentle stream of water. After this, the surface should be covered with a saturated solution of hypo-sulphite of soda, which will almost immediately remove the iodide. Another stream of water must then again be poured over, to free the plate from hypo-sulphite, and the picture is finished.

"In this state they are more or less negative by transmitted light, and, if not too much brought out, positive by reflected light. But I have found the most beautiful and decided positives may be obtained by the simple addition to pyro-gallic solution of a minute quantity of nitric acid; care being taken not to add too much. I have also obtained purple and green pictures, the former by adding acetate of lead, and the latter with acetate of lime and ordinary gallic acid.

"In the hands of skilful operators, who have time and inclination to follow up this interesting branch of photography, I have little doubt but we shall see some beautiful results. At present it is quite in its infancy; but, notwithstanding this, it has been allowed by those who have seen the portraits which have been taken, that they possess far greater beauty than any hitherto produced."

The resulting negative picture on the glass is not quite so adherent as

those formed with albumen; care must therefore be taken to avoid rubbing it off, or the glass plate may be covered with a colorless spirit varnish; by which, when dry, the photographic image is perfectly fixed. In this process the ether, without doubt, plays a very important part; although the largest portion evaporates readily, on intimate chemical combination of this hydro-carbon with the peculiar substance, gun-cotton, employed. At a very early period of photographic investigation, it was found that both alcohol and ether produced several remarkable effects—in some cases the processes were very much quickened; in others the resulting tone of the darkened paper was of a much deeper and richer color. Experiments are yet required to determine the operation of these organic compounds; from the action of many of them it would appear that it is to this order of chemical agents that we have now to look for the greatest improvements in photography.

Lactarine and caseine have been both recommended as media for preparing glass surfaces for the photographic processes. These compounds, which are of a very analogous character, are prepared from buttermilk, by the action of acids; it is proposed that they should be used in solution in ammonia. When this is done, the glass being uniformly coated by flooding the solution over it, it must be allowed to stand in a warm place, free from dust, to dry; this occupies some time, but if the process has been carefully attended to, the resulting coating is very uniform and clear. Iodide of potassium, or of ammonia, may be mixed with the caseine solution, before it is applied; the other parts of the process being precisely similar to those already described.

It has always been deemed of the utmost importance, in the processes on paper, to keep the chemical agents which are to be operated upon by the solar radiations as much as possible upon the surface. Several plans have been proposed, and albuminized paper, has been largely employed. It is, however, found that waxed paper answers far better than any other. The fact that water cannot be spread upon wax may appear to be a difficulty in the way of successful manipulation; but there are means by which this can be overcome, the most successful being the following:

A sheet of good writing paper is placed upon a hot iron plate, and rubbed over with wax until thoroughly saturated, taking care that the wax is uniformly diffused. If there should be an accumulation in any part, the paper is to be held up by one corner, in front of a fire sufficiently hot to liquefy it and allow it to flow off from the opposite corner. A great many sheets of this paper can be prepared at a time, and kept until required. To give these the sensitive coating, a large dish must be procured and filled with a solution of the iodide of potassium; if the paper is simply dipped in, and then removed, it will be found to remain quite dry, owing to the repulsive action exerted between the water and the wax. Sheets of waxed paper are to be passed into the solution one after another, taking care to remove any air-bubbles which may form on the surface of each, until as many as may be required are inserted, and the whole allowed to remain for two or three hours. In that time a considerable quantity of iodide of potassium has been absorbed, and, on removing the papers and drying them, it will be found, upon the application of the nitrate of silver, that a beautiful surface of the iodide will be produced. These papers are highly sensitive, whether we employ the

calotype or the ferrotype process, principally from the circumstance that the chemical agents are retained on their very surface. The resulting pictures are beautifully transparent, not in any respect inferior for copying from than those negatives which are waxed after the picture has been obtained, and all the details are very charmingly preserved.

The addition of the flouride of sodium to the iodide or chloride, is the first preparation of the paper we have alluded to, and there can be no doubt but it possesses considerable accelerating power. This preparation has been recently introduced as a novelty, but the following process is described in the author's "Researches on Light," published in 1844:—

"The fluates of soda and of potash have been used in many different manners, and variously combined. It has been found that the fluate of soda, has the property of quickening the sensibility of bromidated papers to a very remarkable extent; and from this quality, a new process, which I would distinguish by the name of the Fluorotype results. THE FLUOROTYPE. This process, which is characterized by its easy manipulation, and by the sensibility of the papers, when carefully prepared, consists in the formation of a salt of silver, which I suppose must be considered as a fluo-bromide of silver. It is at present somewhat difficult to say which is the most efficacious manner of proceeding; but the difference, as it regards the sensibility of papers, is so very trifling, that this is not of much consequence. The paper may be washed, first, with the bromide of potassium, and then with the fluate of soda; or, which will be found on the whole the best plan, the two salts may be united. The strength of the solution should be as follows:—

Bromide of potassium	20 grains.
Distilled water	1 fluid ounce.
Fluate of soda	5 grains.
Distilled water	1 fluid ounce.

Mix a small quantity of these solutions together when the papers are to be prepared, and wash the paper once over with the mixture, and when dry apply nitrate of silver in solution, 60 grains to an ounce of water. These papers appear to keep for some weeks without injury, and they become impressed with good images in half-a-minute, in the camera. This impression is not sufficiently strong to serve, in the state in which it is taken from the camera, for producing positive pictures, but it may be rendered so by a secondary process. The photograph is first soaked in water for a few minutes; it is then placed upon a slab of porcelain or stone, and a weak solution of the proto-sulphate of iron applied, which very readily darkens all the parts on which the light has acted, to a dark brown; and every object is brought out with great sharpness. When the best effect is produced, the process must be stopped, or the lights suffer. All that is necessary is to soak the paper in water, and then fix with hypo-sulphite of soda."

The processes now recommended are in all respects similar to this:—

It has been found in operating upon landscapes, that the best effects are produced by employing weak solutions of the gallo-nitrate of silver; by choosing clear daylight rather than sunshine—and then allowing the paper to remain in the camera obscura for a prolonged period; that is, from half-an-hour to an hour. In this manner, all the delicate details are brought out—every blade of grass and every leaf impresses its shadow

on the paper, and there are not any of those violent contrasts which destroy the picturesque harmony of many of the calotype landscapes.

The "Daguerreian Journal," published in New York, has just announced the discovery, by Mr. Hill, of a process of obtaining photographs colored by Nature. The manipulatory details are not complete; but we quote Mr. Hill's own words, hoping his expectations may be fully realized:—

"Some two years ago, I took to experimenting, with a view to this great desideratum, but with little faith. In one of my experiments a phenomenon presented itself which greatly surprised me, and, in the nature of the case, compelled me to believe the thing practicable. One color, the red, in a figured dress, was developed as bright as a ruby. I then repeated the experiment, and failed; but, from that hour until a few months ago, I continued to repeat it in every form I could think of, always failing, but never despairing; for I had reasons for believing in the correctness of my theory, that, under certain circumstances, there is on the impressioned plate a latent-colored image. I at length commenced experimenting on the developing power of the vapors of different metals, and found that a large number of them, such as arsenic, cadmium, zinc, selenium, bismuth, potassium, and sodium, would, when properly vaporised, bring out the latent image in light and shade. The same result followed the use of several gases; the impressions differed so little from daguerrotypes, that I was on the point of abandoning the pursuit, when I one day, unexpectedly, formed a singular compound, and, without much hope of success, applied it to my purpose.

"My surprise and joy were unbounded when I found on my plate a true Hillotype. The same process, with some variations, I have followed since, always with good results. I now have forty-five specimens, all of which present the several colors, true to a tint, and with a degree of brilliancy never seen in the richest daguerreotype, and this is true also of the whites and blacks. The pictures have much the appearance of an enamelling, and, I believe, are equally durable, for it is very difficult to efface them by scouring; and, as far as I can judge, they are not acted upon by light. My process bears no resemblance to Becquerel's, and is essentially different from Daguerre's. My success in quickening the plates has been equally gratifying, and I have but little doubt of being able to operate in diffusing light instantaneously, having already reduced the time of setting to much less than that required for daguerreotyping. I have now forty-five specimens; they are all equally perfect. It is quite remarkable that I have never yet made a partial failure. Those impressions which have had too much light, are nearly as strong, sound, brilliant, and beautiful, as those correctly timed in the camera; being inferior only in having the colors less deep; even the whites retain their strength. The folds of the linen are always well defined; blue or solarised linen is unknown in my process, and there is always a strength and clearness in the whites unattainable by mercury. During the last winter I have several times taken a view, in which there is a deep red house, while the ground was covered with snow. For experiment I exposed the plate so long as to reduce the bright red of the house to a very light red, while, at the same time, the white snow was developed with a beautiful whiteness. I have copied several very highly colored French prints; the copies are far supe-

rior to the originals, in that, while they have every tint of color, they are exceedingly brilliant. This is a characteristic in which I never fail, even with the plates merely cleaned with rotten-stone; the brilliancy depending on other causes. Well-polished plates, however, are preferable, for other reasons. It is essential that the plates should be very pure, free from scum, dampness, and organic matter of every kind; and I am experimenting with different substances, in hopes of finding something that will more perfectly cleanse, while it thoroughly polishes. I would be very thankful to any person who might furnish me with valuable hints on this point, as I am convinced that here lies one great cause of uncertainty."

In America there is certainly much zeal displayed in the cultivation of the art of photography. Many of our greatest advances in the art originated in the United States; the first portraits from the life being taken in New York by the professor of chemistry. We are now promised a process by which the great desideratum of impressed color is to be obtained; and the advertising columns of our Journal contain the offer of a prize of 500 dollars for the most important improvement in the art of photography, during the current year. The advantages of stimulating enquiry by offers of this kind, are numerous, and we have but little doubt but that Mr. Anthony's prize will be contested for by the photographic artists and amateurs both in Europe and in America. We hope the result may be the development of some new process by which, with ease and certainty, we may be enabled to obtain still more perfect reflexes of nature than those afforded by the processes we already possess.

Specification of a Patent granted to JOHN MERCER, *of Oakenshaw, Lancashire, for improvements in the preparation of cotton and other fabrics and fibrous materials.*—[Sealed 24th October, 1850.]*

This invention consists in subjecting cotton, flax, and other vegetable fibrous material, and fabrics made therefrom, either alone or mixed with silk, wool, or other animal fibrous material, to the action of caustic soda, or caustic potash, or dilute sulphuric acid, or a solution of chloride of zinc, of such strength and at such a temperature as will produce the effects hereafter mentioned.

The mode of operating, according to this invention, upon cloth made wholly or partially of any vegetable fibres, and bleached, is as follows: The cloth is passed through a padding machine, charged with caustic soda or caustic potash at 60° or 70° of Twaddle's hydrometer, (sp. gr. 1·3 or 1·35,)at the common temperature of the atmosphere, (say 60° Fahr., or under;) then, without being dried, it is washed in water; and, after this, it is passed through dilute sulphuric acid, and washed again. Or the cloth is conducted over and under a series of rollers in a cistern containing caustic soda or caustic potash at 40° to 50° Twaddle, (sp. gr. 1·20 or 1·25,) at the ordinary temperature (the last two rollers being set so as to squeeze the excess of soda or potash back into the cistern); and then it is passed over and under rollers placed in a series of cisterns, which are charged at the commencement of the operation with water only; so

* From the London Journal and Repertory of Arts and Sciences, for June 1851.

that when the cloth arrives at the last cistern, nearly all the alkali has been washed out of it. After the cloth has either gone through the padding machine or through the cisterns, it is washed in water, passed through dilute sulphuric acid, and again washed in water.

When grey or unbleached cloth, made from the above mentioned fibrous material, is to be treated, it is first boiled or steeped in water, so as to wet it thoroughly; then most of the water is removed by the squeezers or hydro-extractor; and, after this, it is passed through the soda or potash solution, &c., as before described.

Warps, either bleached or unbleached, are treated in the same manner; but, after passing through the cistern containing the alkali, they are passed through squeezers or through a hole in a metal plate, to remove the alkali; and then the warps are conducted through the water cisterns, "soured," and washed, as above described.

When thread or hank yarn is to be operated upon, the threads or yarns are immersed in the alkali and then wrung out (as is usually done in sizing or dyeing them); and afterwards they are subjected to the above mentioned operations of washing, souring, and washing in water.

When any fibre in the raw state, or before it is manufactured, is to be treated, it is first boiled in water, and then freed from most of the water by the hydro-extractor or a press; after which it is immersed in the alkaline solution, and the excess of alkali is removed by the hydro-extractor or a press; then it is washed in water, soured with dilute sulphuric acid, and washed again; and finally the water is removed by the hydro-extractor or a press.

The following are the effects produced by the above operations upon cloth made of vegetable fibrous material, either alone or mixed with animal fibrous material:—The cloth will have shrunk in length and breadth, or have become less in its external dimension, but thicker and closer; so that by the chemical action of caustic soda or caustic potash on cotton and other vegetable fabrics, an effect will be produced somewhat analogous to that which is produced on woollen by the process of fulling or milling. The cloth will likewise have acquired greater strength and firmness,—greater force being required to break each fibre. It will be found to have become heavier than it was previously to being acted upon by the alkali; if in both cases it be weighed at the temperature of 60° Fahr., or under. It will also have acquired greatly augmented and improved powers of receiving colors in printing and dyeing.

The effects resulting from the above treatment of the vegetable fibre, in any of its various stages, before it is made into cloth, will be readily understood from the statement of the effects produced on cloth, composed of such fibre, by treating it according to this invention.

Secondly, the patentee employs diluted sulphuric acid, at 105° Twaddle, (sp. gr. 1·52,) and at 60° Fahr., or under, instead of caustic soda or caustic potash—the operation being the same as when soda or potash is used, except the last souring, which is now unnecessary.

Thirdly, the patentee uses a solution of chloride of zinc, at 145° Twaddle (sp. gr. 1·72,) and from 150° to 160° Fahr., instead of the soda or potash, and in the same manner.

When operating on mixed fabrics, composed partly of vegetable fibres and partly of silk, wool, or other animal fibres, such as delains, it is pre-

ferred that the strength of the alkali should not exceed 40° Twaddle, nor the temperature be above 50° Fahr., lest the animal fibres should be injured.

The apparatus and the temperature and strength of the soda or potash, sulphuric acid, or chloride of zinc solution, may be varied to a considerable extent, and will produce proportionate effects: for instance, the soda or potash may be used at a strength even as low as 20° Twaddle, (sp. gr. 1.10,) and still give improved properties to cotton, &c., for receiving colors in printing and dyeing, particularly if the temperature be low; for the lower the temperature, the more effectually the soda or potash acts on the fibrous material. The patentee does not, therefore, confine himself to any particular strength or temperature; but he prefers the strength, heat, and process above described.

He claims, as his invention, the subjecting of cotton, linen, and other vegetable fibrous material, either in the fibre or any stage of its manufacture, either alone or mixed with silk, woollen, or other animal fibrous material, to the action of caustic soda or caustic potash, dilute sulphuric acid, or solution of chloride of zinc, of a temperature and strength sufficient to produce the new effects and give to them the new properties above described, either by padding, printing, or steeping, immersion, or any other mode of application.—[*Inrolled April*, 1851.]

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*On a new Method of Contracting the Fibres of Calico, and of Obtaining on the Calico thus prepared Colors of much Brilliancy.**

Mr. Mercer had his attention drawn to the subject by experiments made as early as 1844. Dr. Playfair briefly called attention to the states of water, the points of maximum density so well known, and the experiments of Mr. Mercer, who found that above this point water flowed more rapidly through a syphon than at the same number of degrees below this point of maximum density. He then spoke of the theoretical views of those chemists who look upon the combined water as in the state of ice, or free from fluidity. Mr. Mercer's discovery may be stated in few words to be this:—a solution of cold but caustic soda acts peculiarly upon cotton-fibre immediately causing it to contract,—and although the soda can be readily washed out, yet the fibre has undergone a change, and water will take its place and unite with the fibre. In a practical view Mr. Mercer considered that the fibre might be considered by this action to have a sort of acid property to unite with soda and then with other bases. The effect of the condensation was said to be one-fifth to one-third of the total volume of cotton employed. Dr. Playfair then showed some proofs of the influence of this new process upon our cotton manufactures; thus, taking a coarse cotton fabric and acting upon it by the proper solution of caustic soda, this could be made much finer in appearance; and if the finest calico made in England, known as 180 picks to the web, was thus acted upon, it immediately appeared as fine as 260 picks. Stockings of open weaving were shown, and the condensation process made them appear as of much finer texture. The effect of this alteration of texture was most strikingly shown by colors. The pink cotton velvet had its tint deepened to an intense degree by the condensation process. Printed

* From the London Athenæum, for July, 1851.

calico, especially with colors hitherto applied with little satisfaction, as lilac, had strength and brilliancy, besides thus producing fabrics cheaply finer than can possibly be woven by hand. The effect was shown of patterns being formed by portions of a surface being protected by gum from condensation. Thus patterns of apparently fine work can easily be produced. It was stated that the fabrics by this process have much strength given them: for a string of calico one-half condensed by caustic soda will break by 20 oz., while the unacted-upon string of cotton broke with 13 oz.

A discussion ensued, by the remarks of Dr. Faraday, Mr. Warrington, and Prof. Dumas and others; and it was proposed that the microscope be employed to ascertain any other obvious change of properties by this new process, that bids fair to exercise an immediate and extensive alteration in the patterns and produce of cotton fabrics. Dr. Playfair, in reply, said, that caustic soda had long been used for bleaching, but this power of altering the texture only belongs to the cold solution of caustic soda. These specimens were the only complete ones, and he had been permitted to bring them from the Great Exhibition to exhibit before the Association.—*Proc. Brit. Asso. for Prom. Sci.*

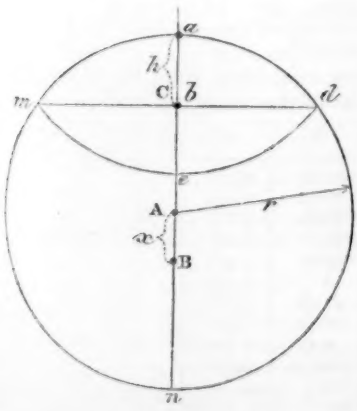
For the Journal of the Franklin Institute.

Gravitation from the Surface of the Earth to its Centre. *By* JOHN W. NYSTROM.

Let A be the whole mass of the Earth, or $A = a\,d\,n\,m$, and a the value of gravity on the surface of the Earth, and r its radius. According to Newton's law,

$$a = \frac{A}{r^2}. \qquad . \qquad . \qquad . \qquad (1.)$$

But at a depth $= h$, from the surface to a point b on the inside of the Earth, the value of gravity will not be $b = \frac{A}{(r-h)^2}$; the *half lens* $a\,d\,b\,m$ attracts the point b upwards in the direction of $b\,a$. To counterbalance this upward attraction requires another *half lens* $b\,d\,e\,m = a\,d\,b\,m$ below the point b, and the remaining mass, $m\,e\,d\,n = B$, is the mass which attracts the point b downwards. The value of gravity will be



$$b = \frac{B}{(r+x-h)^2}, \qquad (2.)$$

when x denotes the distance from the centre of gravity of A to the centre of gravity of B.

Let the mass of the lens $a\,d\,e\,m$=C; then by taking the statical momentum of the two masses B and C, we have

$$B\,x = C\,(r-h)$$

and
$$x = \frac{C\,(r-h)}{B.} \quad . \quad . \quad . \quad (3.)$$

$$A = B + C, \text{ and } B = A - C,$$

but
$$A = \frac{4\pi r^3}{3}, \quad . \quad . \quad . \quad (4.)$$

and
$$C = \frac{2\pi h^2}{3}(3r-h). \quad . \quad . \quad . \quad (5.)$$

$$B = \frac{4\pi r^3}{3} - \frac{2\pi h^2}{3}(3r-h) = \frac{2\pi}{3}(2r^3 - h^2[3r-h]), \quad (6.)$$

from the equations 1 and 2 we obtain $a : b = \frac{A}{r^2} : \frac{B}{(r+x-h)^2}$ from there we get

$$b = \frac{r^2 a\,B}{A\,(r+x-h)^2}. \quad . \quad . \quad . \quad (7.)$$

by insertion of the value of B and C (6 and 5) in the equation 3 will be

$$x = \frac{C\,(r-h)}{B} = \frac{\frac{2\pi h^2}{3}\,(3r-h)\,(r-h)}{\frac{2\pi}{3}\,(2r^3 - h^2[3r-h]).}$$

of which
$$x = \frac{h^2\,(3r-h)\,(r-h)}{2r^3 - h^2\,(3r-h),} \quad . \quad . \quad (8.)$$

by insertion of the value of A and B (4 and 6) in the equation 7 we obtain

$$b = \frac{a\,r^2\,B}{A\,(r+x-h)^2} = \frac{a\,r^2\frac{2\pi}{3}(2\,r^3 - h^3[3r-h])}{\frac{4\pi r^3}{3}(r+x-h)^2}$$

$$b = \frac{a\,(2r^3 - h[3r-h])}{2r\,(r+x-h)^2}. \quad . \quad . \quad (9.)$$

Let a=10, r=10, then x and b being calculated from the formula 8 and 9 at every 10 parts of r, it will be as in the following table.

	h.	*b.*	*x.*
	1	11·75	0·133
	2	13·15	0·475
	3	13·39	0·973
Maximum for *b.*	3·333	14·1	1·15
	4	13·8	1·575
	5	13	2.262
	6	11·45	3·035
	7	9·19	3·88
	8	6·45	4·765
	9	3·265	5·735
	10	0	10·

Suppose the earth to have no rotation around its axis, and a hole be dug from the surface through the centre of the earth, then let a body be

dropped in that hole, the time for its fall from the surface to the centre would be, $T=\sqrt{\frac{R}{g,}}$ if the value of $g=16{\cdot}08$ would remain the same through the hole or falling space; R=radii of the earth in feet. But the foregoing table shows that g increases until one-third of the distance, where it is a maximum. After that it diminishes until it comes to the centre, there $g=o$; but the body has then obtained a certain velocity, and continues its motion towards the opposite side of the earth, there it will return in the same degree until it reaches its dropping point, where it again returns to its first returning point, and will so continue an alternate motion for ever, supposing the hole is empty.

The different values of g at different depths D. is apparent from the foregoing table, g, ${}^{1}g$ ${}^{2}g$ ${}^{3}g$ . . . . . ${}^{10}g=bg$, and the true time for its fall from the surface to the centre will be

$$T=\frac{R}{\sqrt{\frac{R}{10}}\sqrt{g+}\sqrt{{}^{1}g+}\sqrt{{}^{2}g}\ldots.+\sqrt{{}^{10}g.}}$$

or let $\sqrt{g+}\sqrt{{}^{1}g+}\sqrt{{}^{2}g}\ldots.+\sqrt{{}^{10}g}=G,$

we have $$T=\frac{R}{G\sqrt{\frac{R}{10,}}}$$

or at any depth D expressed in feet from the surface,

$$T=\frac{D}{G\sqrt{\frac{R}{10}}}$$

If V denotes the velocity in feet per second at any depth, D and G taken from its corresponding depth,

we have $$V=2G\sqrt{\frac{R}{10.}}$$

The following table will show the different values of T and V. The radius of the earth being R=20935200 feet.

Space fallen through in the first second at depth D. $bg.$	$\sqrt{gb.}$	G.	Time in seconds for the space fallen thro'. T.	Velocity in feet per second at the depth D. V.	Depth from the surface in feet. D.
$16{\cdot}08=g$	4·01	4·01	0	0	0
$18{\cdot}9=\ {}^{1}g$	4·35	8·36	173	24200	2093520
$21{\cdot}1=\ {}^{2}g$	4·6	12·96	223	37600	4183040
$22{\cdot}3=\ {}^{3}g$	4·72	17·98	245	51200	6280560
$22{\cdot}2=\ {}^{4}g$	4·7	22·33	259	64800	8374080
$20{\cdot}9=\ {}^{5}g$	4·57	26·95	268	78000	10467500
$18{\cdot}4=\ {}^{6}g$	4·29	31·24	277	90700	12561120
$14{\cdot}8=\ {}^{7}g$	3·8	35·04	289	101500	14654640
$10{\cdot}4=\ {}^{8}g$	3·23	38·23	300	111000	16748160
$5{\cdot}26={}^{9}g$	2·29	40·56	322	117500	18841680
$0={}^{10}g$	0	40·56	353	117500	20935200

We see by this table it takes 357 seconds, or nearly 6 minutes to fall from the surface to the centre, or 24 minutes to make a passage through the earth and back again. The velocity at the centre will be 117500 feet, or 22·25 miles per second.

Philadelphia, August 1851.

For the Journal of the Franklin Institute.

A List of Steamers in course of Construction in Baltimore, together with their Dimensions, &c.

I. Palmetto Propeller.—The first of a line of steamers to be established between Baltimore and Charleston, S. C. Builder, J. A. Robb; Engines by C. Reeder, Jr.

Length on Deck,	186 feet.
" of Keel,	172 "
" between Perpendiculars,	175 "
Breadth of Beam,	30 "
Depth of Hold,	18 "
Dead Rise,	10 inches.
Tonnage (custom house measurement),	750 tons.

Immersed sectional area at load line, or direct resistance, 224 sq. feet.

Two Direct Action Engines, with Vertical Cylinders.

Diameter of Cylinders,	44 inches.
Stroke of Pistons,	40 "
Diameter of Air Pump,	28 "
Stroke of Air Pump Piston,	20 "

Slide Valves.—Steam Ports, 4×20; Exhaust do., 4×20.

Two Cylindrical Iron Boilers, with double return flues. Length, 16 feet; Diameter, $9\frac{1}{2}$ feet. Fuel, Bituminous Coal.

One Cast Iron Propeller. Diameter $11\frac{1}{2}$ feet; Face, 40 inches; Pitch, $23\frac{1}{3}$ feet. Propeller surface, 98 square feet, being a proportion of propelling surface to area of direct resistance as 1 to 2·28. Length of Propeller shaft, (3 sections,) 72 feet; diameter of do., 10 inches; journals of do., 10×12 inches.

The *Palmetto* is a fine looking vessel, with excellent lines of flotation. Three masted, schooner rigged, with foresail, foretopsail, and foretopgallantsail.

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II. General McDonald.—For the Philadelphia line, to run in connexion with the *Robert Morris* on the Delaware. Builder, J. S. Brown; engine re-built by C. Reeder, Jr.

Length on Deck,	225 feet.
Breadth of Beam,	30 "
Over Guards,	54 "
Depth of Hold,	9 "
Draft of Water,	$4\frac{3}{4}$ "

Hollow lines, coppered and copper fastened.

One Beam Engine, re-built, having been in use for several years on board the late steamer *Constitution.*

Diameter of Cylinder,	52 inches.
Stroke of Piston,	10 feet.
Diameter of Air Pump	40 inches.
Stroke of Air Pump Piston,	44 inches.

Two Iron Boilers, arch and tubular. Fire and flue surface, about 3000 square feet; fuel, wood.

Length of Boilers,	17½ feet.
Breadth,	9 "
Height in front,	10 "
" at back,	8½ "
Diameter of Flues, (internal,)	3 inches.
Diameter of Water Wheels,	31 feet.
Face " "	8½ "
Depth of Buckets,	30 inches.
Diameter of Water Wheel Shaft, (wrought iron,)	13 "

—

III. A side wheel steamer for Savannah, Georgia. R. & E. J. Bell, builders; engine by C. Reeder, Jr.

Length on Deck,	130 feet.
Breadth of Beam,	20 "
" over Guards,	34 "
Depth of Hold,	7½ "

One Beam Engine.

Diameter of Cylinder,	24 inches.
Stroke of Piston,	8 feet.
Diameter of Air Pump,	18 inches.
Stroke of Air Pump Piston,	42 "

One Cylindrical Iron Boiler.

Length of Boiler,	15½ feet.
Diameter "	7½ "

Double return flues, fire and flue surface, 800 square feet; fuel, wood.

Diameter of Water Wheel,	22 feet.
Face of " "	5 "
Depth of Bucket,	20 inches.
Diameter of Shafts, (wrought iron.)	7 "

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IV. A side wheel steamer for La Guayra, South America. Builder, —— Gardner; engines by Murry & Hazelhurst, Vulcan Works.

Length on Deck,	132 feet.
" between Perpendiculars,	130 "
Breadth of beam,	21 "
" over Guards,	34 "
Depth of Hold,	9 "
Tonnage (custom house measurement),	250 tons.

Has a drop deck and is a three masted schooner rigged. Is supplied with two steeple engines connected.

Diameter of Cylinders,	28 inches.
Stroke of Piston,	48 "

One double acting air pump, worked from crank motion of centre shaft.

Diameter of Air Pump.	18⅜ inches
Stroke of " " Piston,	24 "

One Iron Boiler; Double return flues.

Length of Boiler,	15½ feet.
Width of "	10¼ "
Height of "	11 "

Heating Surface, 1000 feet; Fuel, Soft Coal.

Diameter of Water Wheel,	15½ feet.
Face of " "	5½ "
Depth of Buckets,	20 inches.

Hanging Wheel.

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V. A large steamer for the Powhattan Co., The "Belvedere;" Freight and Passengers to Richmond, Va. Builders, Cooper & Butler; engine by Murry and Hazelhurst, Vulcan Works.

Length on Deck,	225 feet.
" between Perpendiculars,	210 "
Depth of Hold,	12 "
Breadth of Beam,	34 "
" over Guards,	58 "
Draft at load line,	9 "
Tonnage (custom house measurement),	840 tons.

Line of Flotation slightly concave.

One Beam Engine.

Diameter of Cylinder,	50 inches.
Stroke of Piston,	10 feet.
Diameter of Air Pump,	3 "
Stroke of Air Pump Piston,	4⅓ "
Area of Steam Valves,	230 sq. inches.

One Iron Boiler, Single Return Flues.

Length of Boiler,	24 feet.
Height of "	13 "
Width of "	11½ "
Diameter of cylindrical part,	11 "

Heating surface, 2200 feet; Fuel, Wood.

Diameter of Water Wheel,	29 feet.
Face " "	9½ "
Depth of Bucket,	2¼ ft.

Buckets radiated from centre of shaft. The "B" is to fill the place of the "Columbus," recently burnt, belonging to the same company.

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VI. A side wheel Steamer for the Norfolk line, Bay route; Builders, Cooper & Butler; Engine by Murry and Hazelhurst, Vulcan Works.

Length on Deck,	245 feet.
" between Perpendiculars,	237 "
Breadth of Beam,	34 "
" over Guards,	60 "
Depth of Hold,	11 "
Draft at load line,	6 "
Tonnage, (custom house measurement,)	864 tons.

One Beam Engine.

Diameter of Cylinder,	56 inches.
Stroke of Piston,	11 feet.
Diameter of Air Pump,	44 inches.
Stroke of Air Pump Piston,	50 "

Two Iron Tubular Boilers.

Length of Boilers,	14 feet.
Width "	14 "
Height "	11 "

Arch below and returns through 4 inch tubes; Fuel, Bituminous Coal; Heating surface, 4000 square feet.

Diameter of Water Wheels,	32 feet.
Face " "	$9\frac{1}{2}$ "
Depth of Bucket,	$2\frac{1}{2}$ "

Buckets radiate from centre of shaft.

The company to whom this boat belongs will find, to their regret, that they have limited the engineers in the size of her cylinders injudiciously. A reservation of power in the capacity of a cylinder to meet exigencies that occur during the winter passages on that route, would certainly more than pay the difference in the first cost in a short time, between a 56 and 60 inch cylinder, in the certainty of her time, and a reduced amount of wear and tear in machinery, owing to the fact that forcing her will be unnecessary.

I have for comparison taken the steamer Vanderbilt, running on the Long Island Sound.

Vanderbilt, tonnage,	1041,	capacity of Cylinder,	339	cubic feet.
Norfolk Boat, "	864 "	"	188	" "
Vanderbilt cylinder, capacity to tonnage is as			1 to 3·07	
Norfolk Boat,	"	" "	1 to 4·05	

Thus showing a proportion of power to tonnage, largely in favor of the Vanderbilt, a boat having very similar duties to perform, to that of the Norfolk boats. S.

For the Journal of the Franklin Institute.

Photographs in Colors.

For the last few months our journals have been occupied with the reported discovery, by a gentleman in the State of New York, of a method of obtaining photographic images of objects in their natural colors, and much anxiety has been expressed to see his pictures. Mr. Hill has not thought proper to publish his process yet, and in the meantime the same results have been arrived at in France.

On the 7th of February, 1848, M. Edmond Becquerel sent to the Academy of Sciences, at Paris, a description of a method of preparing silver plates so as to obtain an image of the solar spectrum. This communication was reported on, (12th Feb., 1849,) by a committee consisting of MM. Biot, Chevreul, and Regnault, and on their recommendation the memoir was directed to be printed in the collection of memoirs presented to the Academy by persons not members. (*Recueil des Savants Etrangers.*)

Since this, several other notices on the subject, by M. Becquerel, will be found in the *Comptes Rendus* of the Academy, and on the 2d June

last M. Niepce sent a communication on the same subject. Neither of these gentlemen were, however, able to fix their images, and it was accordingly necessary to keep them in the dark, but, in the *Comptes Rendus* for 21st July last, we find the following announcement:—

"M. Letillois announces that he has discovered a colorless liquid by means of which he can *fix in a durable manner, upon white paper, all the colors of the prism.* (The italics are the reporter's.) Two specimens of paper thus prepared accompany the note, and present, in truth, colors which, at certain incidences of the light, are very bright and very pure.

"M. Letillois thought that he could obtain the approbation of the Academy for this discovery, by communicating to one member, whom he designates, his process, which he might in other respects keep secret. The usages of the Academy do not permit them to accede to a request made under these conditions."

It is evident that if Mr. Hill desires to have any credit for his invention, he must publish it promptly, as it is probable that the next numbers of the Academy's proceedings will give us M. Letillois' process. F.

For the Journal of the Franklin Institute.

Oscillating Engines for Marine Steamers.

Since the introduction of oscillating engines in the steamers Golden Gate and Illinois, at New York, our friends in that city are disposed to claim the originality of their introduction in this country. They forget that the steamer Republic, built by Murry & Hazelhurst, in 1849, had a pair of engines of that kind, with cylinders 54 inches diameter, and 6 feet stroke; and that since that time, they have put a pair in the Monumental City, diameter of cylinder 44 inches, and 3 feet stroke. T. J. Sutton & Co., of this city, have also built two pair; one for the steamer Col. Fremont, now in the Pacific, and the other in the Albatross, running between this port and Charleston. All of these have been built and put in operation before those of the Golden Gate and Illinois.

For the Journal of the Franklin Institute.

Steamers Building in Philadelphia, August 1st, 1851.

At the works of Merrick & Son, Engineers, Southwark, steamer *Corwin*, belonging to the U. S. Coast Survey. Hull by Vaughan & Lynn, of Kensington.

Length,	125	ft.
Depth of Hold,	10	"
Breadth of Beam,	24	"
Average draft of Water,	7	"

One Steeple Engine.

Diameter of Cylinder,	4 ft.	2 in.
Length of Stroke,	4	
Diameter of Paddle Wheels,	17	6
Length of Paddles,	5	6
Depth of "	1	8

Two Vertical Tubular Boilers, 4 feet 10 inches wide, 16 feet 2 inches long, 8 feet 3 inches high; draft natural; fuel, bituminous coal.

This vessel is built expressly for the Coast Survey service and has

Bunkers for 100 tons of bituminous coal, while her daily consumption on duty will not exceed five tons.

Messrs Merrick & Son have also in hands the machinery for the first vessel of the line now building to run between this City and Savannah, She is to have one side lever engine, cylinder 6 feet diameter and 8 feet stroke; two boilers with horizontal return tubes (internal diameter 3 inches) 9 feet 6 inches long; width of boilers 12 feet; length 14 feet, and height 10 feet 10 inches. Each boiler has 4 furnaces 7 feet 6 inches long. The fuel is to be anthracite coal, with natural draft. Diameter of paddle wheels 29 feet 4 inches, width 9 feet 3 inches, depth of paddles 1 foot 10 inches. The hull is building by Vaughan & Lynn, of Kensington, and is 200 feet long, 33 feet beam, and 21 feet hold, she is expected to equal the steamers Florida and Alabama, now running between New York and Savannah.

Messrs. Reaney, Neafie & Co., of the Penn Iron Works, have in hands the machinery of the Boston steamer William Penn. She has two Vertical direct action Engines, cylinders over cranks.

Diameter of Cylinders,	2 ft. 10 in.
Length of Stroke,	2 10
Diameter of Propeller,	10
Number of Blades	4
Pitch at Centre of Pressure,	20 ft. 8 in.
Two Boilers (each) in length,	21

With a front of 8 feet in width, and same diameter of Shell.

Each boiler has two furnaces with grates 5 feet 3 inches long. There are to each boiler 6 lower flues, and 18 upper return flues; diameter of the latter 7 inches. There is but one chimney, 45 feet high above grate, and five feet diameter. Each engine has an air pump and condenser, the former is so geered that while the piston of the engine makes two double strokes the air pump bucket makes but one. The fuel to be used is anthracite coal, with fan blast. The hull of this vessel is by Birely & Son.

Length on Deck,	180 ft.
Breadth of Beam,	26 "
Depth of Hold,	19 6

Also the Machinery of the Steamer West Wind, intended for the California trade. She has two vertical direct action engines.

Diameter of Cylinders,	2 ft. 6 in.
Length of Stroke,	2 2
Diameter of Propeller,	8 2
Pitch at Centre of Pressure,	18 6

Pirssons fresh water Condenser is used; the air pumps are direct action, and worked from the cross-heads of the engines. There is one boiler 20 feet long, with a front 9 feet 6 inches wide, diameter of shell 9 feet; two furnaces with a grate 5 feet 4 inches long; 8 lower flues, and 18 upper flues, the latter 8 inches diameter. One chimney, height above grate 38 feet, diameter 3 feet 6 inches. Anthracite coal is to be used with natural draft. Hull by Messrs. Thatcher, of Wilmington, Del.

Length on Deck,	160 ft.
Breadth of Beam,	28

Also for the Steamer City of Richmond, to run from New York to Norfolk and Richmond.

Two vertical direct action engines.

Diameter of Cylinders,	2 ft. 2 in.
Length of Stroke,	2 2
Diameter of Propeller,	8 2
Pitch at Centre of Pressure,	18 6

Two air pumps and condensers, the former direct action, with canvass valves. One boiler 22 feet long, 8 feet wide; diameter of shell 7 feet 6 inches; 6 lower flues, and 16 return flues, the latter 7 inches diameter. Two furnaces with grates 5 feet 3 inches long; one chimney 3 feet diameter. Hull by Tees & Birely.

Length on Deck,	153 ft.
Breadth of Beam,	25
Depth of Hold,	17

Also for a steamer to run from Boston to Bangor.

Two vertical direct action engines.

Diameter of Cylinders,	2 ft. 6
Length of Stroke,	2 2
Diameter of Propeller,	9
Pitch at Centre of Pressure,	20 6

Two condensers and air pumps, the latter direct action. One boiler, same size as that for the West Wind. Fan blast to be used. Hull by Birely & Son.

Length on Deck,	160 ft.
Breadth of Beam,	25
Depth of Hold,	9

Also for R. F. Loper, Esq., one sett of Engines and Boilers, the same as building for the Wm. Penn. Hull by Williams & Hoover, of Gloucester, N. J.

Length on Deck,	155 ft.
Breadth of Beam,	26
Depth of Hold,	16

Also for Mail Boat from Vera Cruz to the Amazon River.

Two Direct Action Engines.

Diameter of Cylinders,	1 ft. 8 in.
Length of Stroke,	1 2
Diameter of Propeller,	6
Pitch at Centre of Pressure,	13

One Condenser and two direct action Air Pumps with Canvass Valves. One Boiler, 12 feet long, 5 feet 6 inches wide, and 6 feet 9 inches high. Two Furnaces with grates 4 feet 9 inches long· the flame passes through 2 arches, and returns through tubes. Chimney 2 feet diameter, and 20 feet high above grate; anthracite coal with fan blast to be used, Hull, by Birely & Son.

Length on Deck,	85 feet.
Breadth of Beam,	16 "
Depth of Hold,	7 "

Also a Steamer Tug, for the Harbor of San Francisco.

Two Vertical Direct Action Engines.

Diameter of Cylinders,	1 ft. 10 in.
Length of Stroke,	1 8

One Condenser with two direct action Air Pumps.

Diameter of Propeller,	7 6
Pitch at Centre of Pressure,	15 8

One Boiler 21 feet long, with a front and shell of 6 feet; one Furnace with grate 5 feet long, four lower flues, and fourteen return flues, the latter 6 inches diameter. Chimney, 25 feet high above grate, and 2 feet 3 inches diameter. Hull by Wm. Cramp, Kensington.

Length on Deck,	86 feet.
Breadth of Beam,	19 "
Depth of Hold,	8 "

Messrs. I. P. Morris & Co., of the Richmond Iron Works, have in hand, the machinery of the Boston Steamer, *Benjamin Franklin.*

Two Vertical Direct Action Engines.

Diameter of Cylinders,	3 ft. 4 in.
Length of Stroke,	2 10
Diameter of Propeller,	11 4
Pitch "	35 2
Number of Blades,	4
Length of Blade on the Angle,	6 6

There are two Air Pumps and condensers, the former are direct action, and worked by links from cylinder cross heads. There are two vertical tubular boilers, 19 feet long, 9 feet 3 inches wide, and 10 feet high; each has two furnaces with grates 7 feet long. The engines are connected at rightangles, and the Propeller is attached to the crank shaft without geering; Hull by Birely & Son.

Length on Deck,	180 feet.
Breadth of Beam,	26 "
Depth of Hold,	19½ "

Messrs. J. T. Sutton & Co., of the Franklin Iron Works, have in hands for the Steamer Samuel S. Lewis, to run from Boston to Liverpool, two condensing steam engines with cylinders at an angle of 45°. The crank shaft of the engines being directly over the propeller shaft, with the cylinders below.

Diameter of Cylinders,	5 feet.
Length of Stroke,	3 " 4 in.
Diameter of Propeller,	14 "
Number of Blades,	4

The propeller is geered from the engine shaft, so that while the latter makes 1, the former makes 1¾ revolutions. The large spur wheel is 8 feet diameter, and 3 feet 6 inches face, having several setts of wooden teeth, so arranged as to divide the pitch. There are two boilers, and Anthracite Coal with fan blasts is to be used. The hull of this vessel was built by Birely & Son.

Length on Deck,	225 feet.
Breadth of Beam,	32 "
Depth of Hold,	27 "

They are also building two trunk engines for a large steamer tug to be used on the Delaware, for towing to the Capes.

Area of Cylinders equal to a clear diameter of	2 ft. 8 in.
Length of Stroke,	2 " 6 "